Inspection2000

Space Technologies – Commercial Applications

Technology Exhibit Catalog

NASA Johnson Space Center
Houston, Texas

November 1, 2, 3, 2000

NASA/Johnson Space Center Inspection2000 Exhibit Catalog

About this book…

What is Inspection2000?

It is an opportunity for representatives of industry, business, community, and education to:

- Inspect NASA-developed technologies and processes
- Discover patented technologies available for licensing
- Tour unique facilities
- Learn about Inspection Day success stories
- Discuss technical challenges with our staff

Inspection2000 offers you an up-close look at our work and key facilities. You can participate in various technology presentations and exhibits and visit several different facilities.

By attending Inspection2000 you will discover that our advanced technologies have commercial applications to many industries, and are available to you today! Many of our technologies have already been put to use by industries such as automotive, petroleum engineering, food technology, pharmaceutical, education, mining, agriculture and architecture. Our engineering and science experts will showcase numerous technologies and facilities used to reach the challenging science, engineering, manufacturing, operations and training goals of NASA's Space Program. The technologies exhibited will span the breadth of JSC's work and its diverse facilities.

How do I use this book?

This book is divided into seven disciplines of interest:

- Aerospace
- Business Processes
- Environmental & Health
- Operations
- Outreach
- Research & Development
- Technology Acquisition

Within each discipline, you will find subcategories that may provide more specialized areas of interest to you. For example, if you are interested in materials or manufacturing technology, you can determine which exhibits are on display by going to this catalog's Contents section and looking under Research & Development. Additional handouts provided during Registration will list exhibit locations at JSC. The booth number listed on each page corresponds to a building number (ex. booth 2XX is in building 2).

For additional information about these technologies and the opportunities available to you, please contact:

The Technology Transfer and Commercialization Office
Code HA
NASA/Johnson Space Center
Houston, TX 77058

Phone: 281-483-3809
Fax: 281-244-8452
Email: commercialization1@jsc.nasa.gov
Web Site: http://technology.jsc.nasa.gov

As you view the Inspection2000 exhibits, please remember that there are a number of ways you may use NASA technologies:

1. TECHNOLOGY LICENSING

For technologies that are available for licensing, a license will allow your company to use, modify, and/or sell products, services, and/or processes based on the technology. The Technology Transfer and Commercialization Office (TTCO) can assist you in this process.

2. SUBLICENSE, COOPERATIVE ACTIVITY, AND STRATEGIC PARTNERSHIPS

For technologies already licensed to a private sector company, a sublicense or other cooperative activity may be possible. The TTCO can direct you to an appropriate point of contact at the private sector company.

3. USE OF NASA FACILITIES (REIMBURSABLE SPACE ACT AGREEMENTS)

For use of unique JSC facilities that could benefit your company, Reimbursable Space Act Agreements are possible. Under such an agreement, JSC may perform testing in the facility on a cost-reimbursement basis. The TTCO can also assist in developing a Reimbursable Space Act Agreement with JSC.

4. GOVERNMENT/INDUSTRY PARTNERSHIPS (NON-REIMBURSABLE SPACE ACT AGREEMENTS)

Non-Reimbursable Space Act Agreements are possible when NASA technology requirements coincide with your commercial technology development needs. These agreements generally involve joint development of a technology useful to both NASA and your company. Each party participates in the development effort under the Agreement. NASA obtains rights for Government purposes and your company retains commercial rights. The TTCO can assist you in developing a Non-Reimbursable Space Act Agreement with JSC.

5. PUBLIC DOMAIN

For "public domain" information, we may be able to provide detailed information that can be used in your business. In cases where the information is in the form of computer software, we may be able to provide the software to you under a simple one-page software agreement.

The important point to remember in each of these areas is to contact the Technology Transfer and Commercialization Office (TTCO) if you have any questions or needs regarding our technologies.

Also, please use the Technology Assistance Request form to submit requests. This form is available at each exhibit booth or on the web at http://inspection.jsc.nasa.gov/TAR.

Contents

Human Life Support

Medical

Operations

Automation

Networks and Communications

Robotics

Training Technologies

Virtual Reality

Outreach

Community Outreach

Educational Programs at the Johnson Space Center

Research & Development

Energy Systems

Human Factors

Instrumentation

Manufacturing

Materials

Product Design and Analysis

Research and Test Facilities

Technology Acquisition

Technology Commercialization

Johnson Space Center Inspection2000 Exhibit Catalog

Advanced Communications for Aeronautics

Booth **512**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- Advanced communications for aeronautics research integrates both aeronautics and space communications technologies to achieve the national objectives of increased aviation safety and capacity.
- The Advanced Communications for Air Traffic Management (AC/ATM) Project focuses on articulation of communications requirements and technology development/demonstration for future ATM systems.
- The objectives of the AC/ATM Project are to enable the Free Flight model for air traffic operations and to enable the use of satellite communications for a host of aeronautical applications.
- New terminal technology to conduct broadband air traffic management demonstrations has recently been verified using a specially equipped mobile operations unit with an advanced terminal.
- Another component of advanced communications for aeronautics research is the Weather Information Communications Project (part of NASA's Aviation Safety Program).
- That project seeks to develop advanced information technologies to enable high-quality and timely dissemination of weather information and warnings directly to pilots in aircraft.

COMMERCIAL USES/PUBLIC BENEFITS

- Public benefits include better on-time performance of air carriers, fewer flight delays or cancellations, and safer air travel.

DEVELOPMENT STATUS: IN DEVELOPMENT

Airfield Wind Advisory/Display System

Booth **510**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- The system consists of a self-contained ground weather station that measures winds, temperature, and humidity and transmits it to a handheld device in the cockpit that displays the information.
- It is expandable to wireless Internet-aware devices for both real-time weather and global positioning satellite system applications.
- Its features include automatic operation of both air and ground units, automatic runway selection, automatic activation, and virtually zero maintenance.
- It can work in any country for both military and general aviation.
- It can save three to five minutes per flight by giving the pilot the optimal landing vector in real time before final approach.
- Devices use existing commercial components, such as spread spectrum transceivers, PDAs, and sonic anemometers.
- It is inexpensive to field and operate.

COMMERCIAL USES/PUBLIC BENEFITS

- Market potential includes 5,400 airfields and heloports and 750,000 pilots in the U.S., and about 40,000 airfields and 2 million pilots globally.
- Potential users are all those that need weather-related data (commercial weather services, crop dusters, farmers).

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

A Stable Real-Time Method for Flush Air Data Sensing Systems

Booth **509**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- The FADS algorithm relates measured pressures to the vehicle air data through a calibrated pressure distribution model.
- The model is a splice of the closed-form potential flow solution for a blunt body, applicable at low subsonic speeds; and the modified Newtonian flow model, applicable at hypersonic speeds.
- Once calibrated, the model can be inverted real time to calculate the air data state as a function of the measured pressures.
- An improved solution algorithm allows computation for flow incidence angles to be decoupled from the solution for the Mach number and dynamic pressure.
- The inherent redundancy of the FADS system allows triple-redundant failure capability with only dual-redundant hardware.
- A FADS system using this algorithm design is flying as part of the X-38 closed-loop guidance system.
- The FADS system is the primary air data sensing system for the X-33 and X-34 vehicles.

COMMERCIAL USES/PUBLIC BENEFITS

- The FADS innovation allows air data to be sensed on hypersonic flight vehicles without probing the flow field.
- The nonintrusive nature of the FADS system avoids heating difficulties typical with conventional air data sensors.
- Since the FADS is integrated directly into the aircraft structure, there is no need to deploy an external probe.
- Cost savings for hypersonic flight vehicles is very significant.
- Currently applications for expendable "smart-bombs" and missiles are being considered.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Computational Fluid Dynamics Applications and Tools Booth **501**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- CFD analysis is the numerical simulation of fluid flow over and around an aircraft or spacecraft using computer technology.
- CFD analysis software tools solve the equations of motion for fluid flow over a discretized grid system which models the aircraft or spacecraft geometry.
- At JSC, CFD analysis is applied to calculate aerodynamics of launch and entry vehicles for subsonic, supersonic, and hypersonic flight in the Earth's atmosphere.
- For low-density flows, such as encountered during flight in the upper reaches of the atmosphere or even on orbit, direct simulation Monte Carlo (DSMC) analysis techniques are applied.
- DSMC analysis, a cousin of CFD analysis, computes the movement of the molecules that make up a low-density flow and their interaction with a spacecraft.
- At JSC, DSMC analysis is applied to calculate on-orbit aerodynamics and plume interactions as well as aerodynamics of entry vehicles in the upper atmosphere.
- CFD and DSMC analysis techniques have become powerful engineering tools, complementing test facilities such as wind tunnels, and are now applied to simulate a wide variety of flowfields.

COMMERCIAL USES/PUBLIC BENEFITS

- Aircraft design, development, and optimization
- Automotive industry applications, such as reduced vehicle drag or engine cooling.
- Processes involving internal fluid flows (pipelines, chemical plants, valve designs, etc.)
- Propulsion system development
- Atmospheric sciences and weather prediction

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Electromechanical Actuators

Booth **2203**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- Space-rated EMAs are being developed to support the X-38 spaceflight test vehicle and ultimately the crew return vehicle.
- Eventually, these actuators will replace the hydraulic systems currently used on spacecraft to control mechanical systems such as aerodynamic control surfaces and engine gimbals.
- EMA technology employs electrical power to drive motors that provide mechanical output via a gear train.
- The mechanical output then drives the component of interest.
- Hydraulic systems are at risk for freezing and leaking.

COMMERCIAL USES/PUBLIC BENEFITS

- Improved reliability and maintainability of any actuated system
- Commercial aircraft flight control surfaces and test facilities

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Helicopter Tail Booms With Passive Venting

Booth **511**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- We have developed methods to modify airflow around tail booms in an attempt to reduce adverse forces acting on them, primarily from air flow from the main rotor.
- These methods involve connecting regions of high pressure to regions of low pressure to relieve adverse forces that rob power from helicopters and can make them more difficult to control.
- Methods include using porous material on all or parts of the boom connected to a specific boom cavity opening, and using doors, grilles, slots, or other such openings.

COMMERCIAL USES/PUBLIC BENEFITS

- Increase controllability of helicopters.
- Increase utility, efficiency, and safety of helicopters.
- Reduce power required during hover and low-speed flight conditions.

DEVELOPMENT STATUS: IN DEVELOPMENT

LandForm Real-Time Three-Dimensional Flight Visualization Toolkit

Booth **502**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- The "LandForm" Advanced Flight Visualization Toolkit is a programmer's toolkit of ActiveX controls, which can be used in a Windows environment.
- It has the capability to fly from orbit to touchdown on the runway, with a full three-dimensional planet model.
- Users can combine topography, map, aerial, and satellite images to create a three-dimensional model of the flight test range.
- The program enables flight through world models with 6 degrees of freedom using live data, mission replay, or simulation.
- It has been proven in the real world of X-38 flight testing at Dryden Flight Research Center.
- The program is available as a stand-alone software package or as a programmer's toolkit.

COMMERCIAL USES/PUBLIC BENEFITS

- Replay and analyze flight test data on your desktop.
- Plan emergency aviation depressurization routes.
- Use LandForm as a three-dimensional virtual cockpit window for uncrewed aerial vehicles.
- Train aircrews for hazardous topography landing and takeoff.
- Conduct incident investigation for controlled flight into terrain.
- Use a three-dimensional heads-up display.
- Overlay military sensor imagery with real-time three-dimensional terrain data.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

NASA FutureFlight Central

Booth **520**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- NASA FFC is a full-scale, research and development air traffic control tower simulator.
- In addition to audiovisual support equipment, the facility features programmable user displays that enable the tower to be configured to match the layout of any air traffic control tower.
- The FFC provides a virtually seamless, visual display system that produces a 360-degree out-the-window field of view.
- The FFC can simulate launch and flight operations scenarios at both existing and proposed airports and spaceports.

COMMERCIAL USES/PUBLIC BENEFITS

- The FFC allows airport designers, managers, and operations personnel to develop and test new air traffic management technologies in a realistic simulation of their own airport.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

NASA's Boeing 747, Shuttle Carrier Aircraft

Booth **9905**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- The Shuttle carrier aircraft is a modified Boeing 747-100 aircraft used to transport the Space Shuttle.
- Major modifications to the aircraft structure accommodate forward and aft attachment fittings and vertical fins added to the horizontal stabilizer.
- The aircraft is a "public aircraft" maintained to Federal Aviation Administration requirements.
- Its maximum gross take-off weight is 710,000 lb.
- Its maximum airspeed is 250 KIAS/.6 Mach.
- The aircraft is equipped with four Pratt & Whitney JT9D-7J engines, producing a take-off thrust rating of 48,605 lb each.

COMMERCIAL USES/PUBLIC BENEFITS

- The Shuttle carrier aircraft can provide in-flight transportation of oversized cargo too large for conventional methods.
- It can be used for studies of engine exhaust plumes.
- It also can be used for studies in the enhancement of the commercial 747 classic aircraft/aging aircraft fleet.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Personal Cabin Pressure Altitude Monitor and Warning System

Booth **G23**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- The personal cabin pressure altitude monitor and warning system is a personal safety device that alerts the user of dangerous or deteriorating cabin pressure altitude conditions.
- This technology uses a calibrated, temperature-compensated pressure transducer that functions independently from other aircraft systems.
- The end product serves as an important backup device for pressurized aircraft and is useful for time-at-altitude monitoring for nonpressurized aircraft.
- A standard unit is the size and weight of a personal pager.
- The unit contains a battery, the pressure transducer, a timer, alarms, and a display that indicates the cabin pressure altitude and battery life.
- Other sensors such as oxygen, carbon-dioxide, or carbon-monoxide can be integrated into the system for a complete environmental monitoring system in a shirt pocket device.
- An onboard microprocessor can be easily programmed for monitoring, detecting, and alarming multiple hazardous conditions which might otherwise go undetected.

COMMERCIAL USES/PUBLIC BENEFITS

- The primary application is in the aviation industry.
- Other commercial applications include ground-based aerospace systems (such as vacuum test chambers), altitude chambers, meteorology, and mountain climbing.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Shuttle Cockpit Project

Booth **528**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- This project is seeking to develop a redesigned Shuttle cockpit interface that will allow crews to maintain a better picture of nominal conditions.
- Redesigned Shuttle cockpit interfaces will enhance crews' ability to make the right decisions in off-nominal circumstances.

COMMERCIAL USES/PUBLIC BENEFITS

- Cockpit interface technology could be applied to other air- and spacecrafts.

DEVELOPMENT STATUS: IN DEVELOPMENT

Shuttle Training Aircraft

Booth **9902**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- The STA is a Gulfstream II aircraft, highly modified for Shuttle approach and landing training.
- The STA simulates Shuttle approach profile and handling qualities.
- It is the primary trainer for astronauts' Shuttle landing training.
- Engineers and astronauts also use the STA to evaluate proposed Shuttle changes.

COMMERCIAL USES/PUBLIC BENEFITS

- Develop navigation filters
- Develop control systems
- Develop hardware and software for aircraft uses
- Develop differential global positioning system and flat panel displays

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Shuttle Flight Simulation

Booth **519**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- Ames Research Center maintains a rollout and landing simulation for the Space Shuttle.
- This simulation is used to research and develop Shuttle control systems and handling qualities, as well as advanced display concepts.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology can help with air traffic management from spaceport to orbit to spaceport.
- It is transferable to future space plane projects and may have applications to other airplanes.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Super Guppy Aircraft

Booth **9901**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- NASA's Super Guppy aircraft is the last flying example of the Guppy line of aircraft.
- It is powered by 4 Allison 501-D22C turboprop engines.
- It currently transports larger (oversized) payloads than any U.S.-based aircraft operator.
- International Space Station elements are transported in a specially designed, climactically controlled container that allows operation on the ground and in flight.
- The Super Guppy provides dependable transportation for oversized cargo.

COMMERCIAL USES/PUBLIC BENEFITS

- The Super Guppy aircraft can transport oversized cargo rapidly.
- Its costs are lower than other forms of similar transportation.
- Use of the Super Guppy aircraft is on a cost-reimbursable basis.
- Using flight to move oversized articles can save both time and cost when compared to over-land transportation.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Surface Movement Advisor

Booth **522**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- Surface Movement Advisor is a data system developed at NASA Ames for fusing and sharing aircraft operations data.
- Data is shared among airport users to promote more coordination and efficiency.
- A Surface Movement Advisor prototype has been operational since 1996 at Atlanta Hartsfield International Airport.
- Cost benefit analysis projected a savings of at least $20 million annually due to reduced aircraft taxi times alone.

COMMERCIAL USES/PUBLIC BENEFITS

- Improves timeliness of airline schedules for the traveling public
- Saves airlines money due to less fuel consumed during taxiing and idling on ramps and runways

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

T-38 Product Improvements

Booth **9903**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- The T-38 aircraft is used as a spaceflight readiness trainer for the astronaut corps.
- It provides instrument proficiency training and helps with Shuttle approach and landing training.
- NASA has made these improvements to the T-38 aircraft:
- Added state-of-the-art displays to integrate flight information and increase the safety of flight
- Modified engine inlets to increase takeoff performance through improved inlet airlow
- Redesigned engine ejector to provide long-range cruise performance by directing free-stream airflow
- Incorporated global positioning satellite system to provide position and approach capability

COMMERCIAL USES/PUBLIC BENEFITS

- Head-up display improves safety by providing flight data to the pilot while looking outside.
- Technologies and modifications may be applied to corporate aircraft.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Tour of NASA Unique Aircraft and Technological Aviation Advances

Booth **932**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- Tour NASA's aircraft exhibits at Ellington field. An indepth description for each aircraft will be provided at the exhibit. The aircraft displayed are:
- T-38
- WB-57
- Shuttle carrier aircraft (Boeing 747)
- Super Guppy aircraft (Modified KC-97)
- Shuttle training aircraft (Gulfstream II)

COMMERCIAL USES/PUBLIC BENEFITS

- Unique research and testing opportunities are enhanced using NASA aircraft:
- High-altitude research and testing of new concepts.
- Transportation of articles too large for conventional means.
- New concepts in the field of aircraft propulsion.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Weather Support for the Shuttle Program

Booth **3096**

TECHNOLOGY CATEGORY: AERONAUTICS AND AVIATION

DESCRIPTION

- The National Weather Service Spaceflight Meteorology Group (SMG) provides detailed Space Shuttle landing forecasts and weather briefings to NASA.
- SMG's primary tool is the meteorological interactive data display system (MIDDS), a network of workstations that receive, manipulate, and display global weather information.
- MIDDS has a commercial, off-the-shelf software base with locally customized software providing Shuttle-unique displays.
- SMG's equipment provides its forecasters with detailed weather analysis capabilities to produce forecasts for the Shuttle landing sites in the U.S., Spain, and Africa.
- The equipment's data integration and manipulation capabilities enhances SMG's ability to produce accurate forecasts, which contributes to flight safety.
- The equipment's displays enhance the quality of the briefings to NASA flight directors, astronauts, and senior managers.

COMMERCIAL USES/PUBLIC BENEFITS

- Increased flight safety is in everyone's best interest.
- The weather tools used by the SMG could be used by other weather forecasters.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

A New Generation of Sample Return Missions

Booth **964**

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- Through the collection and study of lunar samples, meteorites, and cosmic dust, JSC has developed extensive experience and unique facilites for curation of astromaterials.
- In the 21st century, comet dust, interstellar dust, solar wind ions, asteroid samples, and rocks and soil from Mars will be returned to Earth and made available for study.

COMMERCIAL USES/PUBLIC BENEFITS

- These missions will provide key information on the formation and the evolution of our solar system.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Astromaterials, Astrobiology, and Planetary Science Booth **935**

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- JSC scientists conduct research on the geology, chemistry, and biology of rock and soil samples from Earth, the Moon, asteroids, and Mars.
- By studying these samples, we hope to understand the origin and the evolution of the solar system and of life itself.
- JSC scientists also use data provided by NASA spacecraft to learn about the solar system.
- JSC is NASA's Center of Excellence for Astromaterials, which include moon rocks, meteorites from Antarctica, and stratospheric dust.
- Astrobiology scientists are doing research connected with the search for possible evidence of life in Mars meteorites and Earth samples.

COMMERCIAL USES/PUBLIC BENEFITS

- Space science research yields advances in basic science knowledge and contributes to education and public literacy.
- Pushing the frontiers of exploration and scientific analysis results in the development of new instruments and technologies.
- The public receives direct access to JSC scientists for an on-the-spot question-and-answer forum about exploration of the solar system - including planetary geology and extraterrestrial research.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Design for Safety

Booth **526**

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- NASA's missions in aeronautics and space exploration entail great technological challenges along with significant hazards and risk.
- As NASA strives to accomplish even more complex and difficult missions, safety remains the Agency's number one priority.
- To accomplish this priority, we must use advanced concepts and technologies to ensure our extremely complex systems are designed and operated safely.
- These technologies include intelligent flight control systems and integrated vehicle health monitoring.

COMMERCIAL USES/PUBLIC BENEFITS

- NASA will be seeking insight and partnerships with industry and academia to meet its number one priority - "Mission success starts with safety."

DEVELOPMENT STATUS: IN DEVELOPMENT

Human Exploration and Development of Space

Booth **963**

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- NASA is investigating key technologies that will enable future exploration beyond low Earth orbit.
- Technologies of interest lead to reductions in the cost of such missions by reducing mass and/or improving efficiencies.
- "Human support" includes health and human performance, habitation, extravehicular activity, surface mobility, and robotics.
- "Transportation" includes Earth-to-orbit vehicles, interplanetary propulsion, cryogenic fluid management, aeroassist, and in situ resource utilization.
- "Power" includes generation, management, and stowage.
- "Information and automation technology" includes communications/networks, operations, intelligent systems, and synthesis environment.
- "Sensor and instrument development" includes science/engineering field lab research, planetary prospecting, sample curation, and environmental and medical monitoring.

COMMERCIAL USES/PUBLIC BENEFITS

- Providing a focus for the advancement of a myriad of technologies
- Advancing international cooperation
- Motivating our youth and exciting the people of the world

DEVELOPMENT STATUS: IN DEVELOPMENT

Human Exploration Operations

Booth **3005**

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- The Human Exploration Operations Team is an advanced planning and analysis group associated with the Mission Operations Directorate Advanced Operations and Development Division.
- Taking advantage of sophisticated computer tools and collaborative engineering environments, the Team supports both remotely hosted design activities and operations-specific product development.

COMMERCIAL USES/PUBLIC BENEFITS

- The structure, charter, and configuration of the Exploration Operations Team is intended to develop advanced business processes and identify advanced technology needs.
- A business or organization can use these techniques in its strategic planning.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

International Space Station, Partnerships for the Future Booth 973

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- The International Space Station partnership exhibit illustrates the theme of the worldwide space community joining together to achieve the goals of the International Space Station.

COMMERCIAL USES/PUBLIC BENEFITS

- Government, industry, and academia from 16 nations will work together to build, operate, and use the Space Station, paving the way for future multinational endeavors.

DEVELOPMENT STATUS: IN DEVELOPMENT

International Space Station—The Future Is Now

Booth **923**

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- The International Space Station is the most complex endeavor ever attempted and the partnership brings together 16 countries in a united effort.
- With the the Russian service module (Zarya) now in orbit, the Space Station is nearly ready for ongoing human presence.
- Numerous other components and capabilities will be added in the near future.

COMMERCIAL USES/PUBLIC BENEFITS

- The International Space Station will foster peaceful relations among the 16 participating countries by building trust and sharing mutual goals for the benefit of all peoples.
- The research carried out on the Station will benefit lives on Earth through medicine, industry, and fundamental science, as well as providing an essential step to future space exploration beyond Earth

DEVELOPMENT STATUS: IN DEVELOPMENT

Lunar Sample Laboratory Facility

Booth **935**

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- This Facility contains lunar geological samples returned by the Apollo astronauts in an environmentally clean facility.
- The Facility is designed for both testing samples in an ultra-clean environment and viewing samples without the need for special measures.
- The lab serves as a model for future storage of interplanetary and planetary samples.

COMMERCIAL USES/PUBLIC BENEFITS

- The lessons learned here have applications to any kind of activity requiring an ultra-clean environment.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Mars Precision Landing

Booth **962**

TECHNOLOGY CATEGORY: NASA PROGRAMS AND EXPLORATION

DESCRIPTION

- Future Mars missions will have stringent precision landing specifications requiring robust and autonomous navigation systems.
- The Martian environment presents significant challenges to the spacecraft entry and landing systems.
- Changing atmospheric conditions, winds, and aerodynamic uncertainties can lead to undesirable situations that must be resolved on board the spacecraft in real time.
- The communication time-delays are too long to consider Earth-based control of a Mars entry spacecraft.
- Can a navigation infrastructure deployed at Mars consisting of orbiting and surface beacons solve the problem?
- Can we expect to achieve precision landings at Mars?
- The answer is yes, and this exhibit discusses how that can be accomplished.

COMMERCIAL USES/PUBLIC BENEFITS

- Could be applied to autonomously navigate and guide aerospace vehicles in the Earth's atmosphere to reduce the risk associated with deorbit and entry operations
- Benefits the education enterprise of NASA by incorporating university professors and students into the process
- Crewed missions to Mars stimulate the young minds of students unlike any other space exploration activity.

DEVELOPMENT STATUS: IN DEVELOPMENT

Cost-Estimating Web Site

Booth **G16**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- Cost estimating is used in all phases of a space mission, from conceptual design through operations.
- The Cost-Estimating Web Site is a central source of information, methods, and tools for estimating the cost of space projects.
- Innovative features such as on-line cost models allow users anywhere, anytime to use the cost methods employed by NASA cost experts.
- The web site promotes better cost-estimating practices and allows designers to focus their efforts on designing cost-effective systems.

COMMERCIAL USES/PUBLIC BENEFITS

- Many of NASA's cost-estimating methods can be used by other industries, such as aircraft or software development.
- The Department of Defense uses the web site to aid in the development of more cost-effective military systems.
- The web site is also used in education as a reference for teaching students the principles of cost estimating.
- Some tools, like the inflation calculator, are also useful to the general public.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Doing Business With JSC

Booth **948**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- JSC actively engages in business activities with large and small businesses, educational institutions, and not-for-profit organizations across the country.
- The Center procures a variety of goods and services through contracts, grants, and cooperative agreements.
- The JSC Industry Assistance Office serves as the primary interface between the Center and the business community for information on how to do business with JSC.

COMMERCIAL USES/PUBLIC BENEFITS

- JSC recognizes that successful achievement of our mission and goals directly depends on an effective partnership between government and the private sector.
- It is vital that we draw on the capabilities of a diverse group of high-quality suppliers.
- This interaction will also help strengthen and diversify the economy.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Emergency Action Tool

Booth **G14**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- The EAT is an implementation technique that ensures coverage for emergency evacuation of a building during a disaster or fire.
- The facility management tracking system defines the responsible personnel and their duties.
- The EAT device is removed from the building during an emergency evacuation and is carried to the rendezvous point or command post.
- The respective fire wardens mark the EAT with a status of "cleared" or "not cleared" for personnel, closed/open fire doors, etc.
- The fire warden team's performance is tracked and analyzed after the emergency, determining level of participation, training, source of problems, and execution time of evacuation.

COMMERCIAL USES/PUBLIC BENEFITS

- The concept is adaptable to electronic implementation and integration into existing building control systems.
- It would also prove valuable to high-rise buildings and to hotels and buildings subject to natural disasters, such as earthquakes and tornadoes.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Facility Management Tracking System

Booth **G15**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- The FMTS is an operational computer software system designed to manage the maintenance, repair, and operations of JSC buildings.
- The FMTS provides the facility manager an automated method to track and integrate work orders, outages, service requests, identified hazards, and safety audits.
- By tracking and correlating these events, related events can be checked simultaneously, and an audit trail created from which building and facility metrics can be developed.
- The FMTS also supplies a web page system to organize and post documentation notices, and report concerning the status of the building or facility.
- Manuals, procedures, and emergency contacts are all available via "hot links" on the facility page.

COMMERCIAL USES/PUBLIC BENEFITS

- The FMTS can be used for management of any complex facility or building that operates on a 24-hour-per-day basis and has significant repair, maintenance, and operations requirements.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Effective Maintenance Practices

Booth **G17**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- A reliable infrastructure is essential at JSC to ensure its many programs can meet their goals.
- An interrupted electrical supply, equipment failure, or environmental incident could hinder the support systems for the Center's high-technology research and many automated systems.
- To ensure integrity and prevent potential disasters, JSC uses an effective maintenance program incorporating the reliability-centered maintenence philosophy.
- This process determines, through analysis, the proper maintenance procedures for our systems to ensure success.
- Using reliability-centered maintenence, maintenance and operations personnel analyze critical assets to determine their true maintenance requirements based on actual asset use.
- As a result, the Center reduces operating costs and improves the assets' reliability and availability.

COMMERCIAL USES/PUBLIC BENEFITS

- The reliability-centered maintenence philosophy has been in existence since 1978, when it was applied to the aviation industry and the United States Department of Defense.
- Since that time this philosophy has been incorporated industry-wide and has exhibited an increase in asset reliability along with reduced maintenance costs.
- Continuous improvements allow this program to be a living maintenance philosophy adopted by the space program with potential space operations applications.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

JSC Quality Management System

Booth **G12**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- The JSC Quality Management Office ensures implementation of the International Standards Organization's requirements for quality management systems (ISO 9000).
- It helps control processes and procedures that affect the quality of products and services.
- It also coordinates internal and external audits of the quality system.

COMMERCIAL USES/PUBLIC BENEFITS

- It helps the Quality Management System policy provide products and services that meet or exceed all customer requirements for safety, performance, cost, and schedules.
- It also results in a better space program for the public.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

NASA and the Small Business Administration—Government Partnering for the Future

Booth **948**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- The SBA helps small and small, disadvantaged businesses contract with government agencies.
- NASA works closely with the SBA to help small businesses participate in business activities supporting NASA's mission.

COMMERCIAL USES/PUBLIC BENEFITS

- The SBA provides financial, technical, and management assistance to help small businesses start, run, and grow.
- The partnership between NASA and the SBA enables small and small, disadvantaged businesses to more easily provide high-quality goods and services to NASA.
- The partnership allows NASA to better take advantage of the innovative and creative talents that can be found in small businesses.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Safety and Health at JSC

Booth **G13**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- Safety and health at JSC incorporates the criteria of OSHA's Voluntary Protection Program (VPP).
- JSC recently achieved Star Status in the VPP, acknowledging the Center's deep commitment to employee safety and health.
- Having a world-class safety and health program brings many benefits to the Center in the areas of employee morale, cost savings, and work quality.
- It also makes JSC a better partner in the community as the lessons learned at work are taken home.

COMMERCIAL USES/PUBLIC BENEFITS

- Any site, big or small, will benefit from a strong safety and health program.
- JSC learned many things on its road to VPP Star Status and those lessons can be applied to most companies and other governmental agencies.
- The Center has training tracking systems, communications strategies, and other safety and health improvements available.
- The Center also participates in VPP's mentoring program by providing guidance to those beginning their VPP journey.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

United States Tax Dollars at Work

Booth **950**

TECHNOLOGY CATEGORY: BUSINESS MANAGEMENT

DESCRIPTION

- See how United States tax dollars spent on NASA contracts directly benefit you.
- This exhibit displays a snapshot of how a requirement for space travel is funded by Congress, contracts are awarded, and spinoff technologies become a part of your everday life.

COMMERCIAL USES/PUBLIC BENEFITS

- The American public directly benefits from the United States space program through spinoff technologies.
- The economy is strengthened through the business generated by NASA.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

JSC's Human Resources Web Sites

Booth **970**

TECHNOLOGY CATEGORY: WORKFORCE

DESCRIPTION

- The JSC Human Resources web sites include descriptive information and on-line services, as well as extensive links to external human resources-related web sites.
- The benefits of retrieving human resources information via the Web include:
- Improvement in the quality and quantity of information sharing
- Timeliness, accuracy, consistency, and availability of information
- Providing customers with easy, 24-hour access to information about the full range of JSC and NASA human resources services, policies, resources, and activities
- Self-service capabilities for updating and obtaining personal information

COMMERCIAL USES/PUBLIC BENEFITS

- The web sites have direct applicability to, and can be used by, other federal agencies.
- Private sector organizations and companies can uSe the web sites' format, layout, and much of the content as a proven, successful model for their own internal human resources web sites.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

JSC's Workforce

Booth **970**

TECHNOLOGY CATEGORY: WORKFORCE

DESCRIPTION

- This exhibit provides an overview of the technical depth and breadth of the workforce at JSC.
- This exhibit provides information on how to get a job at JSC as a student, administrative professional, engineer, or astronaut candidate.

COMMERCIAL USES/PUBLIC BENEFITS

- At the heart of JSC's capabilities are its people.
- Their innovative ideas have taken us to the Moon, and in the near future, will take us to the Space Station and beyond.
- Individually and collectively, they consistently strive to make our Nation's space program a success.

Development Status: **Development Complete/Operational**

Astronaut Images of Earth From Space

Booth **227**

TECHNOLOGY CATEGORY: ENVIRONMENTAL

DESCRIPTION

- Over the years, astronauts have captured thousands of photographic and video images of Earth from space.
- These images are catalogued and available for use by the public.

COMMERCIAL USES/PUBLIC BENEFITS

- Astronaut-acquired Earth imagery is a valuable source of information on planetary processes for scientists, teachers, and media professionals.
- These images tell a compelling story of changing habitat unavailable from any other source.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Earth-Imaging Technologies

Booth **227**

TECHNOLOGY CATEGORY: ENVIRONMENTAL

DESCRIPTION

- JSC is using new Earth-imaging technologies and information processing technologies to acquire Earth images for many geospatial applications and scientific, educational, and outreach uses.
- Astronauts use these technologies in orbit and via robotic means both in space and on the ground.
- They provide a wealth of data for numerous users.

COMMERCIAL USES/PUBLIC BENEFITS

- Earth imaging is valuable in many applications - urban heat island detection, mapping, and updating land cover at various scales.
- These images are also ideal for textbook publishers, educators, and for public outreach.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Improved Amine Chemistry for CO_2 Removal

Booth **222**

TECHNOLOGY CATEGORY: ENVIRONMENTAL

DESCRIPTION

- The Space Shuttle has a flight-tested CO2 removal system that adsorbs CO2 onto adsorption beds, then vents the beds to space vacuum when the beds become full.
- This system can operate indefinitely, with no increase in system weight.
- Recently, a new bed design has been developed that allows for more than twice as much CO2 removal for the same size bed.

COMMERCIAL USES/PUBLIC BENEFITS

- Those interested in CO2 removal from stack emissions will be interested in learning more about this design.

DEVELOPMENT STATUS: IN DEVELOPMENT

Laser-Based Gas Monitor

Booth **222**

TECHNOLOGY CATEGORY: ENVIRONMENTAL

DESCRIPTION

- Commercially available telecommunications lasers can be configured to make spectroscopic instruments that can make extremely precise measurements (at low concentrations) of gaseous contaminants.
- Measurements of SO2, methane, formaldehyde, and ammonia have been made.
- The sensor unit is field ready and has been used to make volcanic gas emission measurements on the flanks of a volcano in Costa Rica.

COMMERCIAL USES/PUBLIC BENEFITS

- Environmental monitors for extremely precise measurements of atmospheric pollutants (such as methane and formaldehyde) can use this type of gas sensor.
- Process control applications can also use this type of laser spectrometer.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Multiuser Droplet Combustion Apparatus

Booth **G04**

TECHNOLOGY CATEGORY: ENVIRONMENTAL

DESCRIPTION

- The MDCA Project at the NASA Glenn Research Center supports NASA's Microgravity Droplet Combustion Research Program.
- MDCA is a multiuser facility designed to accommodate different combustion science experiments.
- The modular approach permits the on-orbit replacement of principle investigator unique components, such as specific fuels and droplet-dispensing needles.
- Large components such as the avionics, diagnostics, and base-plate remain on orbit to reduce up mass.
- MDCA will conduct the experiment in the International Space Station's fluids and combustion facility.
- The MDCA display includes a model of the hardware and a video of operations demonstrating core capabilities of dispensing, deploying, and igniting fuel droplets.

COMMERCIAL USES/PUBLIC BENEFITS

- The ability to conduct droplet combustion experiments in space provides a controlled environment to examine combustion processes.
- Improved understanding of how liquid fuels burn will help in finding more efficient methods of energy production and propulsion.
- This will further aid in understanding the problems of combustion-generated pollution found on Earth.
- These experiments will also provide a better understanding of fire hazards associated with liquid combustibles on Earth and in space.

DEVELOPMENT STATUS: IN DEVELOPMENT

Regenerable Air Purification Using Humidity Swing Regeneration

Booth **222**

TECHNOLOGY CATEGORY: ENVIRONMENTAL

DESCRIPTION

- Odor compounds adhere well to adsorption beds such as charcoal when conditions are cool and dry.
- When conditions become warm and wet, the odor compounds are removed from the bed.
- This system regenerates an odor removal bed using only humidity, rather than steam or heat as is traditionally done.
- The bed is less effective, but energy costs are considerably reduced.

COMMERCIAL USES/PUBLIC BENEFITS

- Indoor air quality systems and industrial emission control systems could be designed using humidity swing regeneration.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Advanced Space Suits

Booth **223**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- Advanced technology space suits feature enhanced mobility systems and lightweight materials.
- These suits are designed to meet operational performance characteristics for future planetary
- surface exploration.
- Test beds are used for demonstration and engineering evaluations of these suits.

COMMERCIAL USES/PUBLIC BENEFITS

- Access to hazardous environment
- Garments for firefighters
- Mobile breathing sources
- Underwater diving industry
- Isolation garments

DEVELOPMENT STATUS: IN DEVELOPMENT

Biological Water Processing

Booth **222**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- We are developing several water treatment technologies to support long-duration space missions.
- Similarities exist between spacecraft water cycles and terrestrial water cycles.
- The exhibit demonstrates an operating biological water processor.

COMMERCIAL USES/PUBLIC BENEFITS

- Extending water supply in terrestrial areas where water resources are limited
- Providing drinking water in areas where the local water supply is temporarily non-potable
- Cultivating public awareness of water reuse

DEVELOPMENT STATUS: IN DEVELOPMENT

Chemical Oxygen Generator With a Novel Aspirator Booth 222

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- The International Space Station needs an oxygen storage and delivery system for emergency use.
- Chemical oxygen delivery systems generate considerable heat when producing oxygen, which presents a fire safety hazard.
- NASA has designed an oxygen delivery system that stores and delivers oxygen, addresses fire safety issues, and operates in a microgravity environment without the use of a fan.

COMMERCIAL USES/PUBLIC BENEFITS

- Underground miners, submarines, and commercial airlines use chemical oxygen delivery systems for emergency use.
- Fire safety applications can benefit from the lessons of this design.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Enzyme-Based Carbon Dioxide Capture and Removal Booth 222

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- A biology-inspired enzyme assists carbon dioxide (CO2) transfer across a membrane.
- The enzyme provides better mass transfer and selectivity than state-of-the-art separation using membranes alone.
- NASA applications focus on CO2 removal from cabin air for transfer to a greenhouse.

COMMERCIAL USES/PUBLIC BENEFITS

- Removal of CO2 from smokestack emissions
- Manufacturing of compressed CO2 in remote locations
- Enrichment of CO2 in commercial greenhouses to improve crop yield

DEVELOPMENT STATUS: IN DEVELOPMENT

Firefighter Suit and Gear

Booth **917**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- Astronauts on a lunar or planetary surface have functional protective suit and gear requirements that are very similar to those for Earth-bound firefighters.
- These requirements include mobility, dexterity, communications, vital life signs sensors, body cooling, and breathing air.
- NASA continues its history of helping firefighters improve their equipment with better breathing air tanks and suit fabrics.
- New efforts are being made to extend these improvements and to look at other areas for applying systems design and knowledge from space suits and vehicles.
- Additional new research applications for firefighters include: cryogenic air breathing and body cooling packs, digital radios and sensors built into helmets, new fabrics, and infrared vision systems.
- Advanced suits will also provide longer-duration protection from flame and metabolic heat.

COMMERCIAL USES/PUBLIC BENEFITS

- Advanced space suit technologies will allow firefighters to work for longer periods of time.
- Firefighters will have enhanced situational awareness in those critical moments of searching for and rescuing victims in residential fires.
- Anyone who performs hard work in a hot environment or who wears protective clothing in hostile surroundings will gain an advantage from this suit.
- Communications devices will allow voice, data, and video two-way transmissions to improve safety.
- Sensors will let people know more about their own health as well as about environmental conditions just outside their reach.

DEVELOPMENT STATUS: IN DEVELOPMENT

Habitability Outfitting (Meal Preparation, Sleeping, and Bathroom Facilities)

Booth **229**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- The exhibit displays a mockup of the Space Station galley, where meal preparation occurs.
- It displays a mockup of the Space Station crew quarters, where sleep accommodations and private work areas are provided for the crew.
- It also displays a mockup of the Space Station waste and hygiene facility, where personal hygiene and grooming functions take place.

COMMERCIAL USES/PUBLIC BENEFITS

- Acoustic isolation technologies
- Personal grooming using minimal quantities of water
- Meal preparation under conditions of restricted power and time

DEVELOPMENT STATUS: IN DEVELOPMENT

Hydroponic Plant Research

Booth **204**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- Texas Tech University, in partnership with NASA, is conducting research on growing plants hydroponically for long-term space missions.
- The primary research goals are to create the most biomass, in the smallest area, in the shortest time.
- Research focuses on crops with high taste/spice content (radishes and onions).
- The project also includes research on water use/hygiene in Mexican border villages.

COMMERCIAL USES/PUBLIC BENEFITS

- Improvement in hydroponic production of vegetables
- New water reuse/recycling technology
- Assisting border villages (and other at-risk areas) to improve water use and hygiene

DEVELOPMENT STATUS: IN DEVELOPMENT

Innovative Spool Valve for Simplified Bed Operation

Booth **222**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- An existing piece of flight hardware for the CO2 removal adsorption bed uses eight different valves and a 22-step bed switching sequence.
- The new generation unit currently under development performs the same bed switching function with a single valve and a single moving part.
- This new spool valve was prototyped and evaluated using stereo lithography, a rapid prototyping technique that allows for relatively inexpensive prototyping of very complicated parts.

COMMERCIAL USES/PUBLIC BENEFITS

- Stereo lithography for rapid prototyping can be used wherever expensive and complicated metal parts with difficult machining are made.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Long-Duration Life Support System Testing

Booth **933**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- This large, multichamber facility will allow testing of advanced life support systems in a closed environment with human test subjects.
- The facility will support testing of integrated biological and physiochemical technologies.
- It will support four human subjects for test durations up to a year and a half.
- It will support a variety of medical, psychological, nutritional, training, and other crew-related testing.
- Test operations within this facility are targeted to begin in 2003.

COMMERCIAL USES/PUBLIC BENEFITS

- Ecosystems control
- Efficient wastewater purification applicable to remotely located or environmentally sensitive terrestrial areas
- Efficient clean-up of contaminated atmospheres; for example, sick building syndrome and industrial pollution control

DEVELOPMENT STATUS: IN DEVELOPMENT

NASA Food Technology Commercial Space Center Booth **206**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- The NASA Food Technology Commercial Space Center is developing foods and food-processing technologies to enhance space missions and advance commercial food production.
- Center objectives include focused research in direct support of the development of food products, food production processes, waste processing, product safety, and terrestrial applications.
- Corporate partners participate with the Center by committing research staff, facilities, and materials to specific product development projects.
- The Center provides access to university research and testing facilities and expertise, and can coordinate access to NASA research facilities and expertise.

COMMERCIAL USES/PUBLIC BENEFITS

- Technologies for safe, nutritious food with a long shelf life
- Development areas including food production, processing, preservation, preparation, and packaging; food safety testing; and waste handling systems

DEVELOPMENT STATUS: IN DEVELOPMENT

Products Developed From Sweet Potatoes and Legumes for Space Missions

Booth **205**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- Sweet potatoes, peanuts, and soybeans are among the crops identified by NASA for long-term space missions.
- Edible and non-edible products have been developed at Tuskegee University's Center for Food and Environmental Systems for Human Exploration of Space.
- Sweet potato products include syrup, drinks, waffles, leaf flour, root flour, and biodegradable paper, among others.
- Peanut products include edible peanut protein film, aqueous extracted peanut oil, peanut butter sopapillas, and milk, among others.
- Soybean products include burgers, milk, raisin bread, tacos, and fajitas, among others.
- Innovative processes in food production and preparation requiring minimal time and use of food material is the focus of product development for space missions.

COMMERCIAL USES/PUBLIC BENEFITS

- The economic value and marketability of sweet potatoes, peanuts, and soybeans may be increased by introducing a number of value-added products.
- Modification of processing technology focusing on low-energy, efficient, smaller-size processing equipment may benefit the industry.
- The development of plant-based biodegradable food packaging could reduce trash levels on Earth, as well as in space.
- Also of benefit is the ongoing partnership among NASA, NASA contractors, small businesses, federal agencies (USDA, NATICK), select foundations, other universities, K-12, and the media.

DEVELOPMENT STATUS: IN DEVELOPMENT

Shuttle/Orlan Space Suits

Booth **223**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- These suits provide the necessary atmosphere, thermal protection, and consumables for astronauts to perform space walks (known as an "extravehicular activity" or EVA).
- Each one comprises an anthropomorphic space suit and the corresponding life support system to enable an EVA for at least 7 hours.
- These suits are modular in design, can be resized on orbit, and can be quickly donned to support an EVA.

COMMERCIAL USES/PUBLIC BENEFITS

- Protective equipment for work in hazardous environments
- Liquid and cooling technologies for thermal comfort inside containment suits (e.g., cooling for firefighters)
- Protective garments fabricated to allow children with porphyria and polymorphic light reaction syndrome (conditions which cause severe allergic reaction to light) to be outdoors

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Simplified Aid for Extravehicular Activity Rescue

Booth **228**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- The SAFER is a jet backpack that astronauts wear on their space suits and serves as an emergency "life preserver."
- Developed at JSC, SAFER was flight-tested during EVAs in September 1994 and used again in March 1996, during EVAs on the third Shuttle mission to Mir.
- A fleet of five SAFERs has been developed for Space Station construction and operations.
- Routine use of SAFERs began on STS-101 in May 2000.

COMMERCIAL USES/PUBLIC BENEFITS

- The SAFER supports the national space goal of human development and exploration of space by increasing the safety of the astronauts and the reliability of the missions flown.
- SAFERs should be seriously considered by any private sector initiative for human space operations.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Food Systems Laboratory

Booth **943**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- The Space Food Systems Laboratory is the research and development facility for space food.
- The Laboratory develops food packaging and preservation methods for the unique constraints of spaceflight.

COMMERCIAL USES/PUBLIC BENEFITS

- Many of the Laboratory's methods are currently used in the food industry.
- There are direct applications to areas with special packaging or preservation requirements due to transportability or storage constraints (such as backpacking).

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Tools and Equipment for Living in Space

Booth **224**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- The exhibit displays the tools used on board the Space Station to diagnose equipment problems and perform repairs when needed, to perform general housekeeping, and to support personal hygiene.
- The exhibit also displays equipment used to restrain crewmembers and equipment in zero gravity, stowage methods, and entertainment systems for crew psychological support.

COMMERCIAL USES/PUBLIC BENEFITS

- Many of the tools and equipement used in the space program come from commercial, off-the-shelf items.
- Some items are modified as necessary for use in space.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Tools for Extravehicular Activity (Space Walks) Booth **224**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- View high-fidelity examples of tools astronauts use to repair the Hubble Space Telescope and assemble and maintain the International Space Station.
- Photographs show the hardware in use on orbit.

COMMERCIAL USES/PUBLIC BENEFITS

- Applications in developing specialized medical tools
- Education of key principles of physics and engineering

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Using Plants in Space

Booth **222**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- Growing plants in space requires efficient lighting systems, nutrient delivery methods, automated systems, and plant cultivars suitable for closed systems.
- Plants provide a source of food as well as a means to recover water, revitalize air, and process waste.
- Growing plants in space can reduce the burden of resupply and increase the level of self-sufficiency.
- Plant growth systems are most applicable for long-duration missions on a planetary surface.

COMMERCIAL USES/PUBLIC BENEFITS

- Electrical and thermally efficient lighting systems, such as microwave lamps and water-cooled lamps
- New light distribution methods using fiber optics and light pipes
- Unique crop production methods with new plant growth substrates, reduced atmospheric pressure, or modified atmospheres
- Crop cultivar development suitable for the special conditions of controlled environment production

DEVELOPMENT STATUS: IN DEVELOPMENT

Vapor Phase Catalytic Ammonia Removal Technology

Booth **209**

TECHNOLOGY CATEGORY: HUMAN LIFE SUPPORT AND TOOLS

DESCRIPTION

- This fully regenerative water recycling technology will apply to Mars exploration missions.
- It is designed to accept a combined wastewater stream and produce potable water in a single-step process.
- A three-year lifetime without resupply or maintenance is planned.

COMMERCIAL USES/PUBLIC BENEFITS

- Vapor phase catalytic ammonia removal technology could be applied to a variety of waste treatment processes.

DEVELOPMENT STATUS: IN DEVELOPMENT

Advanced Clinical Capabilities for International Space Station and Beyond

Booth **974**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- Long-term spaceflight requires new methods for medical observation and treatment of the crew, both on board the vehicle (such as the Space Station) and from the ground.
- NASA is considering numerous medical and communications technologies for space medicine applications.
- Much of the technology under consideration is commercial, off-the-shelf; however, space medicine applications require installation within a "telemedicine" scenario.

COMMERCIAL USES/PUBLIC BENEFITS

- NASA efforts in this field will benefit Earth-based telemedicine capabilities, enhancing the cpability to provide medical aid to any remote location.

DEVELOPMENT STATUS: IN DEVELOPMENT

Advanced Sensors and Technologies for Space Life Sciences

Booth **208**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- Sensors 2000! (S2K!) is a project at Ames Research Center that develops advanced sensor and biotelemetric systems.
- S2K! has built measurement systems for nonbiological measurements in geothermal hot springs, ablative heat shields, and Martian surface weather stations.
- S2K! also builds implantable and externally worn telemetric physiologic monitoring devices.
- S2K! sensors have flown on the Space Shuttle (SLS-1, SLS-2, STS-90, STS-93) and on multiple U.S./Soviet uncrewed Cosmos spaceflights.

COMMERCIAL USES/PUBLIC BENEFITS

- Health monitors for fetal patients
- Health and performance monitors for firefighters and emergency response teams
- Home health care
- Performance monitors of athletes as they train

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Crew Health Care System for the International Space Station

Booth **216**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The CHeCS on board the Space Station consists of three subsystems: the health maintenance system (HMS), the environmental health system (EHS), and the countermeasure system (CMS).
- The HMS comprises medical hardware to provide preventive, diagnostic, and therapeutic care, as well as patient transport capability.
- The EHS consists of environmental monitoring hardware to provide qualitative and quantitative air, water, surface, and radiation monitoring for the internal and external environments of the Space Stat
- The CMS hardware prevents the cardiovascular and musculoskeletal deconditioning that occurs as a result of exposure to spaceflight.

COMMERCIAL USES/PUBLIC BENEFITS

- The CHeCS comprises small, portable instruments designed for use in harsh, rugged environments, which would benefit the medical and environmental industries.
- CHeCS medical kits implement design concepts for packaging to optimize volume and weight that would benefit the airline and other industries.
- CHeCS countermeasures hardware includes in-house designs of exercise equipment that would benefit the physical therapy/fitness industries.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Critical Path Roadmap Project

Booth **220**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- NASA has an evolving program of research and technology designed to prevent risks to humans exposed to the space environment.
- The CPR project is a risk reduction tool designed to help decision-makers focus limited resources on the most critical problems and risks associated with humans in space.
- The CPR web site will contain a relational database that identifies risk assessments, risk mitigation methods, current research and development, and technologies in work.
- There is also a roadmap depicting the critical research and technology development pathways required to enable the biomedical aspects of extended human space exploration.
- Information resources and project management tools (for organizing tasks, schedules, and resources) are also being made available as part of this project.
- Over the next several years, research and technology efforts across several disciplines will focus on mitigating the risks and answering the critical questions that have been identified.
- The areas covered include advanced life support, bone loss, cardiovascular changes, food/nutrition, muscle atrophy, immunology, hematology, neurovestibular adaptation, radiation, and human behavior.

COMMERCIAL USES/PUBLIC BENEFITS

- Industry and the scientific community will have a clear understanding and a prioritization of the types of research and technology development efforts NASA is looking for help with.
- Similar complex endeavors may benefit from the CPR process or the tool itself.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Human Space and Life Sciences

Booth **221**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- This exhibit incorporates hands-on and three-dimensional, interactive, virtual, web-based activities that demonstrate the physiological effects of microgravity on the human body.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology would be most useful to the general public, educators, and students who are involved with education and learning space sciences through use of the Internet.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Ionic Polymeric Artificial Muscles

Booth **915**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The Artificial Muscle Research Institute develops ionic polymeric sensors and actuators that mimic the motion of biological muscles.
- Ionic polymeric artificial muscles can move under the applications of low voltage and low current.
- Ionic polymeric artificial muscles can sense any dynamic disturbance and generate tens of millivolts of electricity.
- Ionic polymeric artificial muscles can also be used in polymer batteries and fuel cells.
- Ionic polymeric artificial muscles have been developed with crawling, flying, and swimming capabilities.

COMMERCIAL USES/PUBLIC BENEFITS

- Any sensing and actuation that must be noiseless and operate in harsh space environments
- Dynamic sensing of structures
- Biomedical fields such as heart assist and compression devices, drug delivery, micro pump and opthalmic applications, and muscular dystrophy aids
- Biotechnological applications such as genome and genetic engineering
- Crystal processing in space

DEVELOPMENT STATUS: IN DEVELOPMENT

Life Sciences Data Archive

Booth **219**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The LSDA is a central repository for the collection and distribution of information on all life sciences spaceflight experiments.
- This information aids scientists in future experiment planning and data analysis, and is located on the Internet at http://lsda.jsc.nasa.gov.
- The LSDA website includes a searchable database, Life Sciences overview, and photo gallery. Educational institutions and the general public can access all research information.

COMMERCIAL USES/PUBLIC BENEFITS

- The LSDA may be useful for any institution or individual that has an interest in data from biomedical research conducted in space.
- Data contained within the LSDA may be useful in establishing countermeasures for a variety of diseases, including bone loss and radiation exposure.
- Lesson plans included on the site assist educators in teaching students in grades K-12 about the various biological processes that are affected during spaceflight.

DEVELOPMENT STATUS: IN DEVELOPMENT

Medical Applications of Microwave Catheters

Booth **226**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- Several applications for using microwave heating via catheters inside the human body have been developed.
- Microwave ablation as a treatment for ventricular tachycardia, a heart problem responsible for 120,000 deaths per year, has been tested in beef hearts.
- Excellent results were obtained with temperature increases in the tissue of 10 to 20 degrees at 1- to 2-centimeter depths.
- Millimeter-wave energy can also be delivered via catheter to precise locations in the coronary arteries to target and heat atherosclerotic lesions.
- The objective is to heat the lesions without damaging the inner lining of the artery, thereby minimizing inflamations and restenosis.

COMMERCIAL USES/PUBLIC BENEFITS

- There are numerous medical applications for these microwave catheters.

DEVELOPMENT STATUS: IN DEVELOPMENT

Medical Informatics and Technology Applications Consortium

Booth **959**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The Consortium develops tools for telemedicine and distance learning.
- It works with test beds that evaluate and validate nascent technologies which have commercial and space applications.

COMMERCIAL USES/PUBLIC BENEFITS

- Technology applications include home health care, distance learning, disaster medicine, travel medicine, and remote location care.

DEVELOPMENT STATUS: IN DEVELOPMENT

Microgravity Exercise System/Biometric Evaluation Platform

Booth **203**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The importance of exercise for maintaining astronaut health and fitness in microgravity environments has been recognized since the early days of human spaceflight.
- The multipurpose, multiaxial, isokinetic dynamometer (MMID) is an isokinetic exercise system/biometric evaluation platform designed for microgravity environments.
- The MMID can simultaneously generate and measure position and force in six degrees of freedom.
- The MMID provides the ability to both exercise and assess strength, muscle coordination, and range of motion.

COMMERCIAL USES/PUBLIC BENEFITS

- The same virtues that make the MMID an outstanding solution for astronauts' exercise needs make it an excellent option for Earth-based exercise and physical therapy.
- As a new exercise technology, MMID is suitable for aggressive commercial development and penetration of the multi-billion-dollar general physical fitness marketplace.
- As a physical therapy system, isokinetic machines are found in physical therapy clinics and chiropractors' offices throughout the world.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

NASA Biotechnology—Bioreactors

Booth **916**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- Advances in biotechnology permit researchers to assemble and manipulate living cells and tissues for the purposes of research, diagnosis, and treatment.
- The NASA bioreactor allows cells to assemble and grow into functional tissues using a rotating vessel that minimizes gravity's effects.
- The bioreactor and related systems are used to investigate the human cell biology of microgravity to help develop treatments and countermeasures for space-related health problems.
- Human cells behave differently in space and our understanding of these differences opens new research opportunities for cancer, diabetes, AIDS, and osteoporosis.

COMMERCIAL USES/PUBLIC BENEFITS

- Cell culture research is a vital part of our understanding of the human body and our fight against disease.
- The benefits that microgravity and the bioreactor bring to cell culture research continue to emerge in the areas of understanding and treatment of disease, tissue engineering, and drug development.

DEVELOPMENT STATUS: IN DEVELOPMENT

NASA Biotechnology—Microencapsulation

Booth **916**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- A new drug delivery system consists of tiny microballoons (slightly larger than white blood cells) containing anti-tumor drugs and radiocontrast oil.
- The microcapsules are designed to be injected into arteries leading into large vascular tumors wherein they become lodged (cutting off the blood flow within).
- The anti-tumor drug is then slowly released into the surrounding tumor tissue.
- The radiocontrast oil allows the microcapsules to be imaged by C-T radiography to map the distribution once they have lodged inside the tumor capillaries.
- This method of "chemoembolization" allows local delivery of the anti-tumor drug directly inside the tumor.
- Thus, less drug can be more effective in killing the tumor cells and the side effects (immune depression, hair loss, nausea) usually found with systemic (total body) chemotherapy can be eliminated.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology can provide a new method for delivery of multiple drugs to large vascular tumors and greatly eliminate the usual side effects of chemotherapy.
- A new version, called "E-T Microcapsules," can be triggered by external magnetic fields to release the drug at specified times.
- Photoactivated drugs have been encapsulated to improve the efficacy of photodynamic therapy of brain tumors using near infrared light, which penetrates more than 20 cm of tissue.

DEVELOPMENT STATUS: IN DEVELOPMENT

NASA Cellular Biotechnology Program

Booth **214**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- NASA's microgravity-based low-shear bioreactor, biosensor, bioreporter, and microencapsulation systems are enabling new approaches to and opportunities in basic and applied biotechnology.
- The use of these technologies on Earth and in space is opening new vistas into the search for understanding and treatment of disease, tissue modeling, and drug development.

COMMERCIAL USES/PUBLIC BENEFITS

- Investigators in medical, university, and industrial laboratories throughout the U.S. are using NASA-designed bioreactors on Earth and in space to grow cells into three-dimensional tissue-like models.
- New insights gained from this technology are enhancing three-dimensional models of cancer to investigate the dynamics of cancer formation, progression, and treatment.
- It is also aiding the engineering of tissues suitable for transplantation such as cartilage and cardiac tissue.
- It can be applied to the growing of infectious agents such as viruses and parasites in human cells and tissues for elucidating pathogenesis and development of vaccines and antibiotics.
- In addition, this technology may be used to help in the development of new drugs.

DEVELOPMENT STATUS: IN DEVELOPMENT

National Space Biomedical Research Institute

Booth **951**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The NSBRI researches and works to develop solutions to the health concerns humans will face on long-duration space missions.
- NSBRI's consortium of 12 research institutions conducts biomedical research necessary for long-duration space travel.
- Initially, the research concentrated on eight areas: bone, cardiovascular, muscle, neurovestibular, human performance factors, immunology/infection, radiation effects, and technology.
- NSBRI now covers four additional areas: neurobehavioral and psychosocial; nutrition; physical fitness and rehabilitation; and smart medical systems.
- The Institute produces educational materials for all grade levels.

COMMERCIAL USES/PUBLIC BENEFITS

- NSBRI will enhance life on Earth by applying the advances in space medicine and technology to similar health conditions on Earth.
- Some conditions on Earth similar to problems associated with space travel include osteoporosis, muscle wasting, orthostatic intolerance, and balance disorders.
- The Institute promotes the transfer of developed technology to non-space applications by including industry partners early in project development.
- Technology projects include a miniature DXA scanner for bone and tissue measurement and a miniature time-of-flight spectrometer.
- In Educational Outreach, NSBRI has developed an on-line version of the high school textbook "Human Physiology in Space" and space-based curriculum materials.

DEVELOPMENT STATUS: IN DEVELOPMENT

New Products for Cell Cycle Research

Booth **202**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- Florida Institute of Technology researches cell culture technology for the production of mammalian cells at precisely defined stages in the cell cycle.
- The cells, normal or immortalized, are produced continuously from undisturbed, growing populations.
- No drug exposures, starvations, or harsh treatments of any kind are involved in the production process.

COMMERCIAL USES/PUBLIC BENEFITS

- The cell culture technology generates new cell cycle products for use in basic research, cancer research, aging research, drug development, etc.
- The products will be marketed as kits of cells, or arrays of purified cell components, at one or more defined stages in the cell cycle.
- In the case of normal cells, the cell cycle products are from cells at defined replicative ages, for use in research on changes in growth and division during aging.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Nutritional Biochemistry Laboratory

Booth **218**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- As NASA moves toward missions of increasing length, nutrition becomes a major factor in ensuring crew health.
- JSC's Nutritional Biochemistry Laboratory is responsible maintaining crew health and safety through ensuring adequate nutrition.
- It conducts operational and research projects to better understand the nutrient requirements for spaceflight, the physiological adaptations to spaceflight, and the maintenance of nutritional status.
- Specific areas of concern include energy intake, body weight and composition, bone health, iron status, radiation exposure and renal stone risk.
- These studies have been conducted on both Shuttle and Mir, and are planned for the International Space Station, and include assessments before, during, and after extended-duration missions.

COMMERCIAL USES/PUBLIC BENEFITS

- Technologies developed as a result of this nutritional research could apply to any area where proper nutrition is a problem or concern.
- The results of the studies on astronauts can be applied to other population groups, as well.

DEVELOPMENT STATUS: IN DEVELOPMENT

Portable Hyperbaric Chamber

Booth **207**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The portable hyperbaric chamber is designed to protect spacewalking astronauts from decompression sickness, commonly know as "the bends."
- In case of a decompression accident during a spacewalk, an astronaut could be placed inside the chamber and treated using a combination of high pressure within the chamber and breathing pure oxygen.
- It uses new technology to create a high-pressure structure using very lightweight and flexible materials.
- This lightweight, stowable chamber can be stored within the International Space Station and used in the event of an emergency decompression accident.
- This exhibit displays the first structural prototype of the portable hyberbaric chamber, which has been designed, built, and tested at JSC.

COMMERCIAL USES/PUBLIC BENEFITS

- Safety device for use where remote diving operations occur, such as diving ships and oil platforms
- Hospitals, sports training, and other medical facilities

DEVELOPMENT STATUS: IN DEVELOPMENT

Spaceflight Cognitive Assessment Tool for Windows Booth 215

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- WinSCAT consists of neuro-cognitive function tests developed from a battery used by the U.S. military and validated in various clinical settings.
- The WinSCAT is completed using a Windows-based computer on board the space vehicle (such as the International Space Station).
- The WinSCAT allows the crew to objectively assess brain functions (not intelligence) during space missions.
- These functions include concentration and attention, mental flexibility, spatial processing, and cognitive processing, as well as short- and long-term memory.
- The program contains encrypted data files, which display current and previous results to the user in table and graph form.
- It is also multilingual.

COMMERCIAL USES/PUBLIC BENEFITS

- The WinSCAT, when installed on a notebook computer, can be used to provide a quick assessment of a patient's cognitive functions in cases of suspected brain damage.
- This application could be used at emergency medical sites, remote work locations, or in hospitals and clinics.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

The Center for Applied Radiation Research

Booth **201**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The Center for Applied Radiation Research studies the effects and mitigation of radiation on photonic, electronic, and bio-systems.
- The sophistication of today's integrated circuits makes them more susceptible to radiation effects, even at radiation levels experienced on Earth.
- Radiation research at the Center seeks to understand the impact of this trend in many aspects of daily life.

COMMERCIAL USES/PUBLIC BENEFITS

- The Center researches the effects of radiation on memory in personal computers, electronic controls on fly-by-wire commerical aircraft, and operating electronics on commercial communication satellites
- Center education and outreach programs span from kindergarten to terminal degrees.

DEVELOPMENT STATUS: IN DEVELOPMENT

Vacuum Resistive Exercise Device

Booth **207**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- The vacuum resistive exercise device is a machine that simulates free weight lifting for astronauts in space.
- It uses air pressure to create a constant force resistance for training.
- Astronauts can use this device in combination with exercise equipment to simulate a wide range of weight lifting activities.
- It has been designed for astronauts to use on the International Space Station.
- This display shows the first prototype, which has been designed, built, and tested at JSC.

COMMERCIAL USES/PUBLIC BENEFITS

- Exercise industry, where free weights could be replaced with a lighter, more portable device
- Applications where a constant force (simulating free weight lifting) is needed

DEVELOPMENT STATUS: IN DEVELOPMENT

Viruses: An Early Indicator of Stress and Diminished Immunity

Booth **217**

TECHNOLOGY CATEGORY: MEDICAL

DESCRIPTION

- Stress arises from a wide variety of life experiences, such as sleep deprivation and job-related events.
- Stress can lead to diminished immunity, resulting in disease.
- Early detection of stress allows for early intervention to minimize disease effects.
- Stress results in many biochemical changes before symptoms appear, but these are difficult to detect.
- All adults carry viruses and antibodies to viruses which increase during periods of stress.
- Increased viral load and/or viral antibodies in body fluids are early indicators of diminished immunity.
- Viral surveillance can be used as an early warning of immune dysfunction before the onset of symptoms.

COMMERCIAL USES/PUBLIC BENEFITS

- This molecular approach for monitoring viruses in body fluids can be used to assess immune status.
- This technology may provide clinically relevant data for management of patients suffering from chronic or acute stress.
- This technology may be useful in assessing immune status during the aging process.
- Viral surveillance may lead to early intervention to minimize adverse effects of acute/chronic stress.

DEVELOPMENT STATUS: IN DEVELOPMENT

Automation Through Operations Assistants **Booth 3007**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- Advanced "operations assistants" will help flight controllers perform data analysis, failure identification/recovery, planning, and system/process management.
- This exhibit highlights the initial phase of the Operations Assistant Project.
- The current software application features automated data and event logging, which sets the stage for intelligent data retrieval and analysis.
- It also lays the foundation for the use of intelligent control and advanced computational techniques, such as intelligent agent-based systems.

COMMERCIAL USES/PUBLIC BENEFITS

- Operations assistants can perform such functions in a wide variety of areas, including chemical plant operations, manufacturing processes, and office activities.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Engineering Animation and Model Building Application (Enigma)

Booth **514**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- An application called Enigma has been developed which can be used for video animation and three-dimensional (3D) model building.
- It supports 3D modeling with cubes, spheres, cylinders, surfaces of revolution, extrudes, and constructive solid geometry.
- Enigma can import/export many industry standard file formats, including AutoCAD, Wavefront, Stereo Lithography/Render and VRML, and can run on Windows, Solaris, Linux, and SGI.
- Video animations can be generated using a key frame animation system.
- Views and models generated by Enigma can be controlled by external programs and users can add customizations.
- Collision detection and minimum distance calculations are generated in real time.

COMMERCIAL USES/PUBLIC BENEFITS

- Prototype visualization.
- Architectural walk-throughs.
- Visualization of simulation data.
- Animation and model building.

DEVELOPMENT STATUS: IN DEVELOPMENT

Intelligent Flight Controller

Booth **523**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- IFC is flight control software that uses neural networks to adapt to changed aircraft flight characteristics, enabling pilots to retain control in accidents or failures.
- The adaptive nature of IFC enables rapid aircraft prototyping and flight simulation during the design stage.

COMMERCIAL USES/PUBLIC BENEFITS

- IFC-equipped aircraft would be able to recover from otherwise catastrophic failures of flight systems and land safely.
- Rapid prototyping and flight simulation of new aircraft designs can save time and money during new aircraft development.

DEVELOPMENT STATUS: IN DEVELOPMENT

International Space Station Logistics and Maintenance Booth 921

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- The International Space Station has no international borders, no organizational lines, and cannot return to Earth periodically for refitting and resupply.
- An international crew must support the Station 24 hours a day, 7 days a week, 365 days a year, requiring a huge amount of supplies and tools.
- The Space Station Logistics & Maintenance Team ensures this support, employing a variety of tools and processes, both on the ground and on board.

COMMERCIAL USES/PUBLIC BENEFITS

- Space logistics is a new concept that will have wide-reaching consequences for both space travel and life on Earth, and is clearly applicable in industry and business.
- Large companies can benefit from learning how to plan for sustained maintenance and prevent avoidable logistics problems.
- Loss of time and resources can be prevented, making sustained operations more economical and less stressful.
- The International Space Station logistics and maintenance process can also be an excellent training tool for employees.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

International Space Station Onboard Electronic Plans and Procedures

Booth **532**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- This exhibit demonstrates the tools that the crew will use on board the International Space Station to view their in-flight plans and procedures.
- The Manual Procedure Viewer is a computer program that contains all the crew onboard procedures available for viewing.
- The Onboard Short-Term Plan is a computer program that contains the crew operational timeline.
- This demonstration shows the electronic linking of the timeline activities to procedures needed for execution.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology demonstrates the adaptation of electronic plans with their associated procedures.
- The technology could be used for executing standard procedures supporting company services and operations.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

JSC Emergency Operations Center

Booth **3097**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- The JSC EOC provides a facility for management and dispatch of emergency response resources.
- It integrates commercially available hardware and software to enable EOC personnel to monitor and allocate resources and minimize response time during emergencies in the upper Texas Gulf Coast area.
- The systems employed in the EOC include security/access control, fire alarm monitoring, and computer-aided dispatch.

COMMERCIAL USES/PUBLIC BENEFITS

- Technologies from the EOC may be applied to any entity performing monitoring and control of a variety of systems.
- Some examples are manufacturing plants, prisons, hospitals, security, and emergency response efforts.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Laptop Computing in Spaceflight and Exploration Booth **533**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- This exhibit provides a simulation of the crew interface for command and control of the International Space Station.
- You will experience a realistic look, touch, and feel of the crew interface, learn how to command the vehicle, and see emergency caution and warning advisories.

COMMERCIAL USES/PUBLIC BENEFITS

- Laptop computing is already being used throughout industry.
- This includes, but is not limited to, oil, petrochemical, medical, business, finance, education, and aerospace.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Low-Impact Docking System

Booth **914**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- JSC is developing a low-impact docking system in conjuction with the X-38 Crew Return Vehicle Program.
- This new docking system is based on a magnetic soft-capture system with a smart, compliant, closed-loop, force-sensing, feedback system to reduce contact loads.
- The system's purpose is to provide a smaller, lighter, smarter, programmable, more reliable, and safer mating interface to mate space vehicles, structures, and/or assemblies.
- Current docking systems in use require two vehicles contacting with high velocities, resulting in high contact loads and critical operations.
- These high loads require a complicated energy absorption system to attenuate the energy once capture has been achieved.

COMMERCIAL USES/PUBLIC BENEFITS

- Applications where vehicles, structures, and/or assemblies need to be autonomously aligned and structurally attached using very low force, either temporarily or permanently
- Cargo/payload ground handling devices, submersibles, space vehicles, and structures
- Multiaxis machining for workpiece positioning and holding

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Neuro Adaptive Controller for Spacecraft Docking

Booth **525**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- This project is developing adaptive neurocontrol technologies to safely, accurately, and efficiently dock a spacecraft to a target under a wide range of difficult operating conditions.
- These neurocontrol technologies learn and compensate for, in near real time, changes in spacecraft mass properties, degradation in thruster strengths, and effects of uncontrolled venting.
- These technologies make spacecraft docking safer, more accurate, faster, and more fuel efficient.

COMMERCIAL USES/PUBLIC BENEFITS

- Any complex control system can be made safer, adaptable, and more robust with this technology.

DEVELOPMENT STATUS: IN DEVELOPMENT

Neutral Buoyancy Laboratory Automated Environmental Control

Booth **934**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- Environmental control systems usually consist of large valves and knobs to control breathing gas systems.
- At the Neutral Buoyancy Laboratory, the system is a state-of-the-art computerized touch screen.
- This system allows the environmental control operator to mix gases and provide breathable gas to multiple suited underwater subjects via umbilical.

COMMERCIAL USES/PUBLIC BENEFITS

- Diving systems automation
- Hyperbaric chamber automation
- Complex remote operations
- Physiological monitoring

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Remote Agent

Booth **524**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- Remote Agent is the first artificial intelligence to operate a spacecraft, demonstrated on NASA's Deep Space One spacecraft in May 1999.
- Remote Agent combines an onboard executive, an automated planner and scheduler, and real-time fault detection and diagnosis capabilities.
- Remote Agent was also able to develop new plans in response to simulated failures of spacecraft components.

COMMERCIAL USES/PUBLIC BENEFITS

- Autonomous operation can reduce the operating costs of many complex systems that currently require large amounts of direct human intervention to monitor and control.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Schedule Graphics Automation

Booth **531**

TECHNOLOGY CATEGORY: AUTOMATION

DESCRIPTION

- This exhibit demonstrates software that creates "presentation-ready" one-page project report graphics from reporting databases.
- The software uses a relational database and commercial, off-the-shelf tools.
- It transfers table and network data from Artemis to Access.
- It transfers Access data to Milestones, Etc. to generate graphs.
- It uses Microsoft Ole (object linking and embedding) commands for the data transfers.
- And it provides both single-project and multi-project capability.

COMMERCIAL USES/PUBLIC BENEFITS

- Anywhere large databases are used to store schedule data that needs to be displayed on a one-page graphic report

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Advanced Communications for Space Operations

Booth **G04**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- Efficiently implementing new communication technologies that use higher frequencies enables enhanced, lower-cost communication services for a variety of applications.
- Emerging technologies and the services built upon them will enable telescience and operations capabilities on a much larger scale and higher data throughput than was ever possible.
- As an example, Ka-band systems enable reductions in size, weight, and power while increasing the data throughput.
- We are developing lower-power, lower-cost, and smaller, more easily integrable Ka-band components to minimize the overall impact of communications subsystems on future spacecraft.
- Developing integrated communications architecture will enable communications links to be established readily among new NASA spacecraft and existing space and terrestrial infrastructure.
- We are currently developing phased array-based communications systems with the objective of demonstrating direct-to-user services at ultra-high data rates.

COMMERCIAL USES/PUBLIC BENEFITS

- These technologies and architectures will give the public sector, industry, and educational institutions greater access to a wider overall communications system bandwidth.
- Direct benefits include the application of Ka-band and space Internet technologies to aviation safety and emergency services at a lower overall cost and increased data throughput.

DEVELOPMENT STATUS: IN DEVELOPMENT

Advanced Guidance, Navigation, and Control

Booth **3003**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- Advanced guidance, navigation, and control technologies being developed will make positioning even more accurate.
- Global positioning satellite technology is being used and augmented for satellite constellation control.
- An Internet-based differential global positioning satellite system allows real-time user positioning on the ground at the 20-cm level.

COMMERCIAL USES/PUBLIC BENEFITS

- Any location in the world with an Internet connection can have real-time tracking and position information to the 10-cm level.
- This technology is especially useful to aircraft and mobile users needing precise knowledge of their location.

DEVELOPMENT STATUS: IN DEVELOPMENT

Distributed Supercomputer

Booth **506**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- The 100% Java Distributed Supercomputer software provides a way to use spare cycles on networked computers in parallel to attack problems which would otherwise require a supercomputer.
- The Java software runs on any machine/operating system supporting the Java runtime environment.
- The software distributes code and data, and tracks available computational resources.

COMMERCIAL USES/PUBLIC BENEFITS

- Many commercial interests spend millions on one-of-a-kind software and hardware to solve computationally intensive problems.
- The Distributed Supercomputer technology provides a portable, cost-effective means of using existing resources to solve problems which would otherwise require costly supercomputer hardware.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Mission Control Center

Booth **3095**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- The Mission Control Center is the focal point for current and future U.S. spaceflight operations.
- The overall operations capabilities allow the Center to support Shuttle, International Space Station, and future human-piloted or robotic spaceflight activity.
- To accomplish this task efficiently and in a cost-effective manner, designers used commerical, off-the-shelf hardware and software.
- The Mission Control Center features distributed architecture allowing international operations and the world's largest fiber data distributed interface network.
- A collaborative user/developer environment is used to build software applications.
- A generic approach to the Mission Control Center promotes rapid reconfiguration to support diversified operations.

COMMERCIAL USES/PUBLIC BENEFITS

- The architecture and approach used and the experience gained in developing a large control center could be applicable to other large operation control centers.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Mission Services Delivery

Booth **3002**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- Mission Services Delivery uses the commercial standards being developed for B2B (business-to-business) applications and applies them to spacecraft operations systems.
- Mission Services Delivery leverages commercial providers in modern B2B relationships to provide space operations services.

COMMERCIAL USES/PUBLIC BENEFITS

- Expansion of the standards for data interchange established with Mission Services Delivery could be applied to operations needing command and control.
- Operations where the operations team is remote from the device/plant being controlled would benefit from this technology.
- This technology enables operations teams and equipment to be spatially distributed by providing common data interfaces compatible with Internet data transfer.

DEVELOPMENT STATUS: IN DEVELOPMENT

Neutral Buoyancy Laboratory
Underwater Communication

Booth **934**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- The NBL underwater communications system allows divers in the NBL to hear communications with the suited subjects underwater.
- The system operates on two channels so that two tests can take place under the water at the same time and communications from one test will not interrupt the other test.
- The battery-operated system is a small "soda-can"-size receiver all the divers wear, with a two-inch vibrating "microphone" worn under the diver's mask strap against the side of the head.

COMMERCIAL USES/PUBLIC BENEFITS

- Underwater sensors, communications, or telemetry
- Monitoring and tracking
- Emergency notification

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Qualification and Utilization of Electronic System Technology

Booth **3004**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- The QUEST program is aimed at identifying technologies that will advance the state of the art in command, control, planning, and training operations.
- The current prototypes include a cockpit avionics prototyping enviroment, a commercial router for space applications, and a fiber channel storage area network for the Mission Control Center.
- Another prototyping effort that is being investigated is a knowledge portal infrastructure for the Mission Control Center.
- The QUEST program is also looking into advanced operations concepts to support a Mars mission including intelligent systems, alternative display devices, and wireless networks.

COMMERCIAL USES/PUBLIC BENEFITS

- The prototypes and technology investigation conducted by this program could be used by any other industry that has a command center for operations.
- The prototyping environment that will be demonstrated could be used as a model for prototyping any aircraft cockpit design.

DEVELOPMENT STATUS: IN DEVELOPMENT

Remote Experiment Operations Using Space Internet Technologies

Booth **3001**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- Advanced communications technologies are combined with commercial Internet protocols to demonstrate the remote operation of an experiment, as will be possible with the Space Station.
- The exhibit comprises hardware located at several JSC buildings, and uses an operational tracking and data relay satellite system and NASA gateway located at White Sands Test Facility.
- Operating a laptop in one building, the system communicates over the open Internet via the Space Station network demonstration hardware to control an experimental package in another building.
- This exhibit is the first live demonstration of the application of space Internet technologies to remote experimental command and control.
- Auxiliary technologies included in the demonstration permit the secure transmission of data over the open Internet.

COMMERCIAL USES/PUBLIC BENEFITS

- Ka-band and space Internet technologies are directly applicable to aviation safety, seismic exploration, emergency services, or any mobile communication application.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Ring Buffered Network Bus

Booth **508**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- The ring buffered network bus is a nerve center within a network of applications, enabling synchronized data distribution, application integration, and collaborative processing.

COMMERCIAL USES/PUBLIC BENEFITS

- Engine health monitoring on aircraft
- Collaborative research among engineers and scientists
- Distributed applications across wired and wireless networks

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Internet

Booth **3001**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- Space Internet technologies extend terrestrial-based Internet into NASA missions to enhance the opportunity for remote access and control.
- The Space Internet provides the operations community with greater control and flexibility over experiments while reducing costs to NASA.
- The goal is to achieve seamless interoperablity between satellite and terrestrial networks, resulting in reduced integration risk and cost.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology is directly applicable to wireless Internet applications like cell phones, PDAs, and mobile computing.
- The aviation industry could use this technology to provide Internet access to passengers during flight.
- Seismic exploration and emergency services could take advantage of this work to provide interoperable communications to remote sites.

DEVELOPMENT STATUS: IN DEVELOPMENT

Telescience Support Center

Booth **3098**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- The Telescience Support Center has been developed to support JSC-sponsored experiments on the International Space Station.
- The term "telescience" is used because the experiment investigators will support the operations from their home institution (university, etc.) rather than physically coming to a NASA facility.
- The Center will employ state-of-the-art systems, software, and procedures to distribute data to remote users without compromising the privacy of the science data.

COMMERCIAL USES/PUBLIC BENEFITS

- Implementing the concepts and tools for remote operations will permit greater participation in research activities to be conducted on the Space Station.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Voice Over the Internet Protocol

Booth **3006**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- The VOIP provides the capability to distribute secure voice communication channels to desktop computers over standard computer networks, including the Internet.
- VOIP is monitor only.
- VOIP uses encrypted MP3 multicast technology.
- VOIP can support multiple audio channels without individual dedicated lines.
- VOIP allows for distributing voice or audio channels where bandwidth is limited.

COMMERCIAL USES/PUBLIC BENEFITS

- VOIP can be used to distribute voice or audio in operations environments.
- VOIP could be used in hospitals, plant operations, or for security.
- The commercialization potential of this technology lies in reducing the network bandwidth overhead associated with current voice distribution technologies and costs for dedicated audio lines.

DEVELOPMENT STATUS: IN DEVELOPMENT

Wireless Headset Universal Interface Adapter

Booth **G23**

TECHNOLOGY CATEGORY: NETWORKS AND COMMUNICATIONS

DESCRIPTION

- The primary purpose of this headset adapter is to replace electromechanical and wired connections between a communicator and communication equipment with a remote wireless link.
- The unit provides commercial, off-the-shelf wireless headsets with a necessary "push-to-talk" capability.

COMMERCIAL USES/PUBLIC BENEFITS

- This device would benefit communications systems used by the Department of Defense, air traffic controllers, and law enforcement and public safety (e.g. 911) call centers.
- It could also be used in commercial call centers, such as telemarketing.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Biclops

Booth **905**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The Metrica pan/tilt/vergence camera mount (Biclops) is a three-axis motion-control platform for aiming stero cameras.
- The device is fast, precise, lightweight, and has embedded control electronics.
- This project was done by Metrica under an Small Business Innovative Research Grant partnership with NASA.

COMMERCIAL USES/PUBLIC BENEFITS

- Because of the Biclops' low power consumption, it is ideal for use in autonomous robots.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Bird's Eye View

Booth **912**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- BEV tools provide situational awareness to astronauts by displaying synthetic camera views of vehicles, robotic arms, and other mission-specific payloads.
- These tools, hosted on a laptop computer, provide a variety of viewpoints that are unavailable with existing cameras and windows.
- BEV provides the Shuttle flight crew with synthetic three-dimensional images to track the progress of robotic operations during a mission.
- BEV of the International Space Station will help crewmembers maintain overall awareness of the progress and relative position of the Orbiter and Station robotic arm and structure elements.
- BEV can be used to observe payload and spacewalking crewmember clearances from structures and obstacles.
- Motion control system BEV provides the crewmember with guidance, navigation, and control information about the International Space Station.

COMMERCIAL USES/PUBLIC BENEFITS

- Situational awareness tools providing the user with an overall view of a specific task where direct viewing is limited
- Situational awareness tools providing an alternative viewpoint using a three-dimensional graphical display to allow the user to view a task from any viewpoint

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Dexterous Robotics Laboratory

Booth **910**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The Dexterous Robotics Laboratory provides development support for robotic grasping technology.
- It contains robotic development test beds for cooperative manipulator tasks, the robotic astronaut assistant (Robonaut), and an operating environment for teleoperation of robotic systems.

COMMERCIAL USES/PUBLIC BENEFITS

- The Laboratory provides a development environment for researchers in robotic grasping and cooperative robotic arm and hand operations.

DEVELOPMENT STATUS: IN DEVELOPMENT

Extravehicular Activity Robotic Assistant

Booth **908**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The extravehicular activity robotic assistant is a mobile robot designed to assist during extravehicular activity on a planetary surface such as the Moon or Mars.
- This project is exploring the interaction requirements between a suited astronaut and a robot.
- The robot will engage in many activities, including video coverage, navigational assistance, trailer towing, and carrying tools and samples.
- The robot uses a variety of sensors, including voice recognition, stereo vision, sonar, compass, global positioning satellite, and laser range-finder.

COMMERCIAL USES/PUBLIC BENEFITS

- Hands-off communication and cooperation between humans and robots
- Efficiently conducting tasks in underwater, construction, and mining environments

DEVELOPMENT STATUS: IN DEVELOPMENT

Manipulator Development Facility—Shuttle

Booth **901**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The Manipulator Development Facility emulates the Shuttle remote manipulator system.
- It employs a 50-foot, hydraulically actuated manipulator arm.
- Operating control inputs are processed by a computer system, which furnishes control signals to the manipulator arm.
- Hand controllers and switches provide rotation and translation of arm joints and are located at the operator console.
- An end effector attaches to the manipulator wrist to grapple simulated payloads.
- The Facility supports crew training and development of flight procedures for payload handling.

COMMERCIAL USES/PUBLIC BENEFITS

- Robotics for control of industry operations

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Multiuse Remote Manipulator Development Facility—Space Station

Booth **901**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The Multiuse Remote Manipulator Development Facility emulates the Space Station remote manipulator system.
- It employs a 60-foot, hydraulically actuated manipulator arm.
- A computer system that processes operating control inputs furnishes control signals to the manipulator arm.
- Hand controllers that provide rotation and translation of arm joints are located at the operator console.
- An end effector attaches to the manipulator wrist to grapple simulated payloads.
- The Facility supports crew training and development of flight procedures for payload handling.

COMMERCIAL USES/PUBLIC BENEFITS

- Robotics to control industry operations

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Neutral Buoyancy Laboratory Robotics

Booth **934**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The Neutral Buoyancy Laboratory has two different robotic arms that astronauts use to train Space Station assembly procedures.
- Both robotic arms are hydraulically operated.
- The controlling software makes them behave just like the robotic arms on the Space Shuttle and Space Station.
- Both robotic arms are 95% titanium to be strong, lightweight, and corrosion resistant.

COMMERCIAL USES/PUBLIC BENEFITS

- The manipulator part of the robotic arms demonstrates technology associated with remote manipulation in up to 7 degrees of freedom.
- Remote manipulation is useful in hazardous environments where it is difficult for people to work safely for very long.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Personal Satellite Assistant

Booth **907**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The personal satellite assistant is for intravehicular activities and crew activities within spacecraft, including the International Space Station.
- It is being developed as a 5-inch spherical robot that uses fans to propel itself within spacecraft.
- It is equipped with stereo cameras, proximity sensors, an inventory tag reader, and environmental sensors.
- The personal satellite assistant will be capable of being remotely operated and locally commanded using conversational speech.
- It will also have a planner/scheduler integrated within its control software to provide a high level of autonomy.
- Earth-based scientists can use the personal satellite assistant to observe their Space Station experiments.

COMMERCIAL USES/PUBLIC BENEFITS

- Educators can use the personal satellite assistant to watch events and allow students to interact with the crew.
- Its sensing and other operating features could be applied to many different kinds of ground-based robots.

DEVELOPMENT STATUS: IN DEVELOPMENT

Pneumatic Transporter

Booth **903**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The pneumatic transporter uses inflatable bladders around a cylindrical payload to move large objects over unknown, potentially rough surface terrain.
- By inflating bladders behind the payload and deflating bladders ahead of the payload in sequence, the transporter rolls slowly across the terrain.
- Obstacles are absorbed by the bladders in this transporter.

COMMERCIAL USES/PUBLIC BENEFITS

- Transportation of large objects over rough terrain on Earth
- Use of high-strength, flexible, puncture-resistant materials

DEVELOPMENT STATUS: IN DEVELOPMENT

Robotic Hands

Booth **910**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- A variety of robotic hands have been developed at JSC over the years and are being displayed.
- The latest hand to be developed is the Robonaut hand.
- The Robonaut hand is a highly anthropomorphic, human-size, twelve-degrees-of-freedom, five-finger hand that is capable of manipulating a variety of tools.

COMMERCIAL USES/PUBLIC BENEFITS

- Robotic hands have potential uses in applications ranging from manufacturing to work in hazardous environments.
- The human-like hands also have potential application in the prosthetics industry.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Robotic Search for Antarctic Meteorites

Booth **904**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- NASA's Cross Enterprise Technology Development and Telerobotics Programs fund the Robotic Search for Antarctic Meteorites Project.
- Carnegie Mellon University has led the research, robot development, and three demonstrations in Antarctica.
- The project's major accomplishment in 2000 was the the Nomad robot's first-ever discovery of Antarctic meteorites.
- Nomad combined science autonomy and advanced robotic intelligence to seek the meteorites.
- This project has proven the value of autonomous robots in science missions analogous to the exploration of Mars and the Moon.

COMMERCIAL USES/PUBLIC BENEFITS

- Robots with Nomad's technology could become mobile labs or provide useful work in Arctic and polar regions.
- Nomad's autonomous search and classification capabilities could be used in a variety of commercial and defense applications.
- The project, in collaboration with the BigSignal Intitiative, has created a very successful education and public outreach program which has engaged thousands of students and dozens of schools.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Robotics Systems Evaluation Laboratory

Booth **986**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The Robotic Systems Evaluation Laboratory performs engineering evaluations on the use of robotics technologies.
- It currently emulates the Canadian special purpose dexterous manipulator for robotic compatibility testing.
- The Laboratory simulates the International Space Station camera views and special purpose dexterous manipulator tool changeout mechanisms to verify replacement of hardware units.
- Robotic verification includes evaluation of the robotic operator/robot interfaces and the robot/replacement hardware interfaces.

COMMERCIAL USES/PUBLIC BENEFITS

- Remotely controlled or automated operations
- Working "by hand," but remotely and in a very precise fashion, such as in a company that works with manufacturing genes
- Within education, to support student robot competitions fostering critical analytical and thinking skills

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Serpentine Robotics

Booth **906**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- Serpentine robots are chains of simple, low degree-of-freedom modules that collectively form a highly flexible robot.
- These mechanisms can be controlled by mimicking snake motions.
- They have unique advantages over other robotic configurations.
- They are highly flexible, adaptable, and maneuverable in tight spaces and over large obstacles.

COMMERCIAL USES/PUBLIC BENEFITS

- Serpentine robotics enable systems to traverse irregular, obstacle-filled areas (e.g. earthquake debris).

DEVELOPMENT STATUS: IN DEVELOPMENT

Six-Degrees-of-Freedom Dynamic Test System

Booth **911**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The SDTS is a real-time dynamic motion simulator whose principal purpose is to simulate the relative dynamics of two bodies in space.
- It is a hydraulically powered Stewart Table with interactive human/computerized control.
- The Table is 6 degrees of freedom with a vertical and lateral motion range of 120 inches, angular motion range of ±20 degrees (3 axes), 10,000 pounds load capacity, and motion control to .006 inch.
- It was originally designed to test full-scale docking systems, and it can accommodate actual flight hardware.
- Additional capabilities include the emulatinf the Shuttle remote manipulator system and the Space Station remote manipulator system to perform berthing operations.
- The SDTS incorporates a Shuttle cockpit mockup with selected control panels, both computer-generated and actual camera views of the test hardware, and a force feedback loop.

COMMERCIAL USES/PUBLIC BENEFITS

- Motion-based rides in the amusement industry
- Cockpit trainers in the aerospace industry
- Six-axis machining tools
- Advances in mechanism design, hydraulic actuation, computer control, and simulation

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Systems Laboratory

Booth **913**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The Space Systems Laboratory at the University of Maryland conducts research and has made advances in space telerobotics, extravehicular activity, automation, and advanced controls.
- The Laboratory is developing the Ranger telerobotic Shuttle experiment, which is planned for a spaceflight in 2002.
- The Ranger robotic system includes state-of-the-art electrically driven robot manipulators with interchangeable hands.
- Other research includes advances in spacesuit design, in-suit biomechanical instrumentation, automation, and advanced nonlinear controls.

COMMERCIAL USES/PUBLIC BENEFITS

- This research is relevant to space, undersea, and remote hazardous operations.
- Fundamental technologies include advanced manipulator and space mechanism design.

DEVELOPMENT STATUS: IN DEVELOPMENT

Systems Engineering Simulator

Booth **912**

TECHNOLOGY CATEGORY: ROBOTICS

DESCRIPTION

- The systems engineering simulator consists of multiple high-fidelity cockpits used for Shuttle and Space Station operations driven by high-fidelity, integrated models of the Shuttle and Space Station.
- The simulator also houses three workstations that can run part-task simulations, such as a Shuttle robotic arm simulation or a Space Station robotic arm simulation.
- It is designed for maximum flexibility in developing computer-based vehicle response, interface graphics, and out-the-window and television images.
- The simulator supports engineering analysis for Shuttle and Space Station, training for Shuttle missions and Shuttle-based Station operations, and some conceptual design work for advanced exploration
- Cockpits available to be toured are a Shuttle aft cockpit in a 25-ft-diameter dome, a Shuttle forward cockpit, and a Space Station robotics workstation.
- The Shuttle robotic arm simulation workstations will also be active.

COMMERCIAL USES/PUBLIC BENEFITS

- Prototyping vehicles and/or robotic manipulators for operator-in-the-loop testing
- Testing integrated systems and subsystems where human interaction is important
- High-fidelity crew interfaces
- High-fidelity, integrated, dynamic models of the on-orbit environment

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Computer-Based Training for Astronauts

Booth **503**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- This exhibit demonstrates how astronauts use desktop computer-based training programs to prepare for spaceflight.
- Learn how computer-based training allows astronauts to prepare individually, as time permits, and to focus on the training material and methods they need for a particular mission.
- You will also have an opportunity to understand computer-based training development.

COMMERCIAL USES/PUBLIC BENEFITS

- NASA's expertise in computer design, specifically its progress in computer-based desktop computer training, can be integrated into any industry that has to train individual employees.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Crew Compartment Trainer

Booth **985**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The crew compartment trainer is a high-fidelity, full-scale mockup of the Space Shuttle crew station.
- Flight crews learn to operate many of the Space Shuttle subsystems in over 20 different classes.
- Flight-like audio, closed-circuit television, and lighting systems provide astronauts and engineers with a realistic Space Shuttle environment.
- The trainer can be repositioned in the nose-up attitude for prelaunch training.

COMMERCIAL USES/PUBLIC BENEFITS

- Private industry may benefit from the concept of mockups, training, and facility dual use.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Field Deployable Trainer—Crew Onboard Support System

Booth **505**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The COSS is a series of computer-based reference and training refresher applications crew members use on the ground and on orbit.
- COSS training and support materials contain multimedia elements and are delivered via CD-ROM.

COMMERCIAL USES/PUBLIC BENEFITS

- Schools, universities, and industry can use tools used for COSS development to develop low-cost, high-quality education, training, and support products.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Intelligent Math Tutor

Booth **506**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The Intelligent Math Tutor is a Web or CD-ROM tool for self-paced learning of college or pre-college mathematics.
- The tutor includes modules for fundamentals of mathematics I and II; introductory, intermediate, and college algebra; and college trigonometry.
- This tool may be used as a self-contained course including textbook, or as a supplement to corespondence courses.
- Expert system methodologies are used to track the students' progress and provide feedback.

COMMERCIAL USES/PUBLIC BENEFITS

- Roughly 40% of students taking remedial math courses in college do not pass the first time.
- The Intelligent Math Tutor is a cost-effective method to deliver lesson content at the student's pace and convenience.
- The technology used to develop this course could be applicable to intelligent, computer-based training used in government, industry, and academia - and commercially marketable as such.

DEVELOPMENT STATUS: IN DEVELOPMENT

JSC Educational Technology

Booth **506**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The JSC Learning Technologies project has developed a suite of Web-based applications for K-12 students and educators.
- NASA Qwhiz <http://prime.jsc.nasa.gov/Qwhiz> is an interactive, question/answer web game that teachers can use for learning reinforcement and assessment and for teaching technology skills.
- The ROVer Ranch <http://prime.jsc.nasa.gov/ROV> is an on-line robotics workshop and simulation environment based on NASA's missions such as the International Space Station.
- The Intelligent Math Tutor provides automated instruction in remedial mathematics at the college or pre-college level.

COMMERCIAL USES/PUBLIC BENEFITS

- The JSC Educational Technology effort employs state-of-the-art Internet technology to bring the NASA mission into the classroom.
- In addition to their uses for public education, these applications could be adapted for corporate training, sales, advertising, or other public outreach activities.

DEVELOPMENT STATUS: IN DEVELOPMENT

JSC's Language Education Center

Booth **970**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- JSC's Language Education Center enables our employees to gain proficiency with the native languages of our Space Station foreign partners.
- Russian is the primary language currently taught; however, some Japanese, Italian, and French classes are also offered.
- The Language Education Center consists of 9 classrooms and a multimedia lab which provides employees the opportunity to enhance their speaking, listening, and comprehension skills.
- This is done by using computer stations with interactive software, audio stations, TVs and VCRs, and a library of resource materials.

COMMERCIAL USES/PUBLIC BENEFITS

- Our facility and curriculum may be of interest to companies that require their employees to gain proficiency in a foreign language while still maintaining their current job responsibilities.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

NASA Qwhiz

Booth **506**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- NASA Qwhiz is an on-line, interactive Web game based on the NASA mission.
- Players can become Qwhiz makers by building their own qwhizzes on line.
- Since it is Web-based, Qwhiz can be played from any computer with a browser and Internet connection.
- K-12 students at different locations can play each other in real time.

COMMERCIAL USES/PUBLIC BENEFITS

- Qwhiz could be used for corporate training, public outreach, or promotions.
- Users can construct their own qwhizzes on line with no special training or software.
- NASA subject matter can help make the study of science and math fun.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Partial Gravity Simulator

Booth **987**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The partial gravity simulator, commonly referred to as Pogo, is a pneumatically operated actuator suspended from an overhead air-bearing rail.
- Pogo provides both partial gravity and microgravity simulations in the vertical axis for a crew member supported by a gimbal assembly.
- Pogo can also suspend various payload objects from the end of the pneumatic actuator.
- Pogo is used for astronaut training and for evaluating astronauts' ability to perform tasks in partial gravity and microgravity environments.

COMMERCIAL USES/PUBLIC BENEFITS

- Pogo can be used as a training device in physical therapy for patients who have suffered injuries to the spine or legs.
- This simulator, or a scaled-down version, could be used to off-load a patient's weight in varying degrees until the patient is able to walk on his own.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Precision Air-Bearing Facility

Booth **989**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The 32-foot by 24-foot metal surface of the Precision Air-Bearing Facility provides a two-dimensional simulation (three degrees of freedom) of a weightless environment.
- The Facility is an engineering tool and crew training device to develop and teach large mass-handling techniques.
- Previous missions that have used the Facility include the Solar Max repair, Palapa/Westar retrieval, and Hubble Telescope servicing mission.

COMMERCIAL USES/PUBLIC BENEFITS

- The mockups and trainers are used to support flight design and human factors research and testing, crew training, education and outreach, and public awareness.
- Private industry may benefit from the concept of mockups, training, and facility dual use.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Real-Time Simulation on Clustered PCs Using Linux Booth **530**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- Large clusters of PCs were added as part of the computer system upgrade for the Space Station Training Facility.
- These PCs can even be used for high-performance applications and full system simulation of the International Space Station, and they are used individually or in small clusters for specific tasks.
- Several computer technologies have been merged to provide real-time capabilities across a wide performance range.

COMMERCIAL USES/PUBLIC BENEFITS

- The approach will extend real-time performance from small, stand-alone systems to large clusters of personal computers.
- This technique can provide significant cost savings in equipment (at least 5:1) over other solutions.
- Key products will be released to the open source community for worldwide use.

DEVELOPMENT STATUS: IN DEVELOPMENT

ROVer Ranch

Booth **506**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- ROVer Ranch is a Web-based simulation developed for K-12 students to design, build, train, and run robots in a virtual environment on line.
- The initial mission is based on a visual inspection of the International Space Station.
- The simulation includes a three-dimensional virtual reality modeling language model of the International Space Station.

COMMERCIAL USES/PUBLIC BENEFITS

- Students can use ROVer Ranch to construct virtual science projects on line.
- Teachers can use the standards-based content and activities to reinforce topics in science and mathematics.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Shuttle Mission Training Facility

Booth **598**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The Shuttle Mission Training Facility is the primary training facility for crew training in the Shuttle Program.
- It includes the fixed-base simulator, guidance and navigation simulator, and motion-base simulator.
- It is used for on-orbit operations training in the areas of payloads, rendezvous, remote manipulator tasks, and launch and landing.
- Each simulator has its own instructor station that allows instructors to monitor and control the simulation, input malfunctions, and execute procedures.

COMMERCIAL USES/PUBLIC BENEFITS

- The facility demonstrates how high-fidelity complex training can be conducted in a simulated environment.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Station Mockup and Trainer Facility

Booth **991**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The SSMTF is a full-scale replica of the International Space Station.
- The SSMTF includes selected Russian modules, task trainers, and systems with communications connectivity to other JSC facilities.
- Rapid prototyping is used to support Space Station design, development, integration, and procedure and hardware verification.
- The mockups and trainers support flight design and human factors research and testing, crew training, education and outreach, and public awareness.

COMMERCIAL USES/PUBLIC BENEFITS

- Private industry may benefit from the concept of mockups, training, and facility dual use.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Station Training Facility

Booth **529**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The SSTF is the cornerstone for Space Station astronaut and flight controller training.
- The SSTF is the only facility capable or providing the full system simulation of the Space Station vehicle, including all system interfaces and interactions.
- The SSTF software was developed using structured programming and software model code reuse.

COMMERCIAL USES/PUBLIC BENEFITS

- SSTF technology could be useful for any large-scale real-time simulator effort.
- The SSTF software uses an object-oriented modeling methodology and a special simulation executive software layer.
- This software design makes it possible to integrate the various system models and also encourages the reuse of existing code to reduce costs.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Vehicle Mockup Facility

Booth **984**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- The Space Vehicle Mockup Facility houses several unique facilities used to support flight crew training, space hardware and procedures development, education and outreach, and public awareness.
- These facilities include a full-scale International Space Station module elements mockup and three Space Shuttle mockups.
- It also includes two air-bearing facilities, a partial gravity simulator, and various part-task mockups and trainers.

COMMERCIAL USES/PUBLIC BENEFITS

- Private industry may benefit from the concept of mockups, training, and facility dual use.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Spaceflight Resource Management

Booth **504**

TECHNOLOGY CATEGORY: TRAINING TECHNOLOGIES

DESCRIPTION

- Spaceflight resource management is training designed to complement safety by minimizing human error and its effects in all realms of human spaceflight.
- It focuses on the six performance elements that are paramount to humans in the spaceflight environment: Command, leadership, communications, situational awareness, decision-making, and workoad management.

COMMERCIAL USES/PUBLIC BENEFITS

- The philosophies and content of spaceflight resource management can be used in virtually any technical environment, including the fields of transportation, medical, industrial, and power generation.
- While airlines have been using a form of spaceflight resource management called crew resource management successfully for some time, our system is designed to go beyond the crew.
- It is designed to enhance safety in all realms of the human technical environment.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Ames Virtual GloveboX: Life Sciences Tool for Astronaut Training and Simulation

Booth **521**

TECHNOLOGY CATEGORY: VIRTUAL REALITY

DESCRIPTION

- NASA Ames' Center for Bioinformatics is developing a Virtual GloveboX for astronaut crew training.
- The Virtual GloveboX will permit simulations of experiments in the life sciences glovebox aboard the International Space Station.
- The Virtual GloveboX will provide a realistic "reach-in" immersive virtual environment, mimicking the real glovebox environment.
- It will use smaller-sized, affordable PC-based computing technology to bring training opportunities to astronauts.
- Simulations designed to help develop experimental procedures will improve performance and efficiency.
- Further developments of the Virtual GloveboX will provide an advanced "fine sensory-motor coordination" training and simulation system.
- Ultimately, this technology could be taken aboard the Space Station to provide continued life sciences glovebox training for complex procedures.

COMMERCIAL USES/PUBLIC BENEFITS

- Simulation tools to assist in preoperative surgical planning and predictive outcome
- Educational tools to advance training procedures for residents in surgical subspecialties
- Instructional tools for university laboratories
- Industrial applications like real-time simulation of bench or robotic procedures

DEVELOPMENT STATUS: IN DEVELOPMENT

International Space Station Synergistic Engineering Environment

Booth **513**

TECHNOLOGY CATEGORY: VIRTUAL REALITY

DESCRIPTION

- This software system is a virtual simulator that models the ISS vehicle and system performance in any user-selected configuration and environment.
- The ISS Synergistic Engineering Environment is designed to help the engineering collaboration among distinct organizational groups supporting the ISS program at various NASA centers.
- The application will allow geograhically distributed engineers and scientists to immerse themselves, along with multiple analytical simulations and data, into a synthetic ISS environment.
- Users may quickly and efficiently evaluate operational procedures and contingencies, and assess configuration and technology enhancements during the assembly and operational phases of the ISS.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology could be applied to any complex system that is being developed in multiple locations or being engineered after being placed in service.
- The collaborative capabilities enable cost and time savings resulting from reduced travel.
- Multiple simulations can be incorporated into a complete virtual environment.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Synthetic Vision for Space Vehicles

Booth **516**

TECHNOLOGY CATEGORY: VIRTUAL REALITY

DESCRIPTION

- Langley Research Center is developing new technologies for the “cockpits of the future.”
- The Synthetic Vision System allows pilots to see the oncoming terrain in all types of weather conditions, thus providing a much safer operating environment for the pilot, crew, and passengers.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology can be applied to commercial air travel.
- As the next generation of transportation systems evolve, synthetic vision systems and other advanced cockpit technologies will be required to ensure safe operations.

DEVELOPMENT STATUS: IN DEVELOPMENT

Systems Analysis Tools and Models for Space Vehicles Booth 515

TECHNOLOGY CATEGORY: VIRTUAL REALITY

DESCRIPTION

- Powerful new systems analysis tools are being developed at Langley Research Center for analyzing radical new aerospace vehicle concepts.
- These analytical tools allow the designer to explore a wide range of new vehicle concepts in a very short time.
- The tools also provide information on which technologies need to be developed to ensure the safest and least costly configurations that meet a broad range of NASA space mission requirements.
- They have already been employed in the design of the Shuttle and International Space Station, and are enabling NASA's next generation of space systems.

COMMERCIAL USES/PUBLIC BENEFITS

- These technologies can also be applied to increase safety, reduce cost, and improve performance of air travel for the general public.

DEVELOPMENT STATUS: IN DEVELOPMENT

Virtual Reality for Extravehicular Activity

Booth **909**

TECHNOLOGY CATEGORY: VIRTUAL REALITY

DESCRIPTION

- The exibit demonstrates the integration of virtual reality hardware and software technologies that are used to familiarize astronauts in extravehicular activities.
- A head-mounted display is used to take the participant on an external tour of the International Space Station configuration currently in orbit around the Earth.
- Additional capabilities will be presented by videotape.
- These other capabilities include equipment training, remote manipulator system operations, and single- and multiple-person integrated 6-degrees-of-freedom mass handling.

COMMERCIAL USES/PUBLIC BENEFITS

- Training and evaluating human operations

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Apollo Era Mission Control Center

Booth **3094**

TECHNOLOGY CATEGORY: COMMUNITY OUTREACH

DESCRIPTION

- The Mission Operations Control Room-2 (MOCR-2) was the control room used for support of early crewed spaceflight operations, including Apollo 11.
- The MOCR-2 is indicative of the technology used for the Gemini, Apollo, Apollo Soyuz Test Project, Skylab, and early Space Shuttle missions.
- The facility demonstrates the technology used for flight control operations through mid-1996.
- It includes mainframe computing, custom-designed hardware, black and white monitors, hand-wired systems, pneumatic tubes, and long data reconfiguration processes.

COMMERCIAL USES/PUBLIC BENEFITS

- The United States Department of the Interior has designated the MOCR-2 a National Historic Landmark.

DEVELOPMENT STATUS: IN DEVELOPMENT

Benefits of Space on Tour

Booth **G99**

TECHNOLOGY CATEGORY: COMMUNITY OUTREACH

DESCRIPTION

- Technology from the space program touches all our lives each day, including things now taken for granted, like smoke detectors and cordless tools.
- This touring exhibit endeavors to highlight some of the benefits we have derived from technology originally developed in support of NASA's mission.
- Some technologies coming into wider use include a miniature, implantable heart assist device based on Space Shuttle fuel pumps and protective clothing based on space suit technology.

COMMERCIAL USES/PUBLIC BENEFITS

- There is tremendous potential for even greater future benefits for the public from the exploration and development of space.
- These secondary uses, or "spinoffs," include important life-saving devices, as well as applications that further enhance our everyday living and improve the economy.

DEVELOPMENT STATUS: IN DEVELOPMENT

Download: Space!

Booth **213**

TECHNOLOGY CATEGORY: COMMUNITY OUTREACH

DESCRIPTION

- Learn how to find out about NASA programs and projects on the Internet at http://spaceflight.nasa.gov.
- NASA's Human Spaceflight Web contains a wide variety of information about the Space Shuttle and Space Station.
- The information includes the latest status reports, launch schedules, assembly sequences, crew interviews, and schedules.
- Plus, there are many reference documents such as operations manuals and training guides.
- And there are still images, digitized video, streaming NASA Television and a host of interactive features.
- Finally, you can actually track space vehicles on line and find out how to see them streak overhead from your own backyard.

COMMERCIAL USES/PUBLIC BENEFITS

- Internet technology is in widespread use around the globe, but this site shows how to seamlessly integrate web content into other business processes.
- In addition, it shows how the government and NASA are working with commercial hardware, software, and service vendors to share its information cost-effectively.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Earth and Space Science Education and Public Outreach

Booth **210**

TECHNOLOGY CATEGORY: COMMUNITY OUTREACH

DESCRIPTION

- Experience activities, view products, and discuss partnerships with personnel from JSC's Earth and space science education and public outreach team.

COMMERCIAL USES/PUBLIC BENEFITS

- The public receives direct access to Earth and space science education activities, products, and potential partnerships through this JSC project.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

International Space Station Trailer Exhibit

Booth **G98**

TECHNOLOGY CATEGORY: COMMUNITY OUTREACH

DESCRIPTION

- The Space Station Trailer exhibit brings the excitement of human exploration of space down to Earth.
- Interactive displays and an informative and entertaining video guide visitors through the habitation and laboratory modules.
- Designed as an exhibit, not a replica or mockup, the trailer exhibit is aimed at a general public audience.
- Visitors move through in groups of 15 and it takes approximately 15 minutes to view the exhibit.

COMMERCIAL USES/PUBLIC BENEFITS

- The Space Station Trailer Exhibit works to improve public understanding of the International Space Station Program.
- Even people unfamiliar with the space program can come away with an understanding of how astronauts will live and work aboard the laboratory.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

JSC Community Support

Booth **212**

TECHNOLOGY CATEGORY: COMMUNITY OUTREACH

DESCRIPTION

- JSC provides outreach to the community through activities designed to educate the public about human spaceflight.
- The annual Open House event allows thousands of visitors to tour full-size Shuttle and Space Station mockups, sit in the cockpit of T-38 jet aircraft, and listen to astronauts discuss living in space.
- The Speaker's Bureau provides speakers for public speaking engagements around the country.
- In support of Shuttle missions, JSC invites the public to special viewings of the launch and landing and to postflight briefings by the recently flown crew members.
- The International Space Station mobile exhibit is a trailer-based interactive experience to share with the public the excitement of living and working in space.

COMMERCIAL USES/PUBLIC BENEFITS

- JSC's Community Support Program strives to inform and excite the public about the exploration of and benefits from space.
- The Program informs the public of JSC's role in human spaceflight and highlights the Center's role as a participating member of the community.

DEVELOPMENT STATUS: IN DEVELOPMENT

JSC Oral History Project

Booth **211**

TECHNOLOGY CATEGORY: COMMUNITY OUTREACH

DESCRIPTION

- The JSC Oral History Project gathers information from individuals who first provided the country and the world with an avenue to the Moon and beyond.
- Digital audiotape captures the words, expressions, and inflections from oral history sessions conducted with these space pioneers.
- The Project also rescues data on deteriorating and obsolete media, using reel-to-reel players and state-of-the-art electronic components to capture and transfer all products to digital format.
- All of this information is recorded onto compact discs so that current and future generations can access and relate to "real life" events that occurred decades ago.
- Web sites being developed combine the verbiage of the oral history participants with imagery to showcase NASA's glorious past.
- In addition, book projects bring home a combination of imagery and descriptions of the success stories of NASA.

COMMERCIAL USES/PUBLIC BENEFITS

- The personal recollections from the participants of the Oral History Project encourage all who listen to explore avenues of science and technology and to make the dreams of spaceflight become real.
- Sharing the thoughts and experiences of these individuals provides numerous opportunities to bring the excitement of space exploration to people of all ages.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

K-12 Student Programs

Booth **971**

TECHNOLOGY CATEGORY: EDUCATION

DESCRIPTION

- JSC involves students in rich and challenging experiences to promote their interest in pursuing further studies in science, mathematics, engineering, and technology.
- The Mars Settlement Design Competition is an exciting industry simulation game for high school students conducted over a weekend spent at JSC.
- The NASA Student Involvement Program allows students to participate in engineering investigations and design challenges.
- Through the Science Advisor Program, volunteer science and engineering professionals develop relationships with educators at schools to augment their science knowledge and skills.
- The Summer High School Apprentice Research Program stimulates student interest in science and engineering careers.
- Students from across Texas can participate in the Texas Aerospace Scholars Program through an interactive online learning experience highlighted by a weeklong program at JSC.

COMMERCIAL USES/PUBLIC BENEFITS

- Through the Office Education and the High School/High Tech Programs, high school students of varying abilities and backgrounds are offered job opportunities and summer internships.
- Participants in K-12 student programs receive the benefits of coupling practical experience with their school experience, leading to a greater understanding of actual employment environments.
- Experiential programs for students contribute to developing the highly trained, technical workforce needed to support our future economy.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Lunar and Planetary Institute

Booth **952**

TECHNOLOGY CATEGORY: EDUCATION

DESCRIPTION

- LPI develops innovative ways to use planetary science in the K-12 classroom and informal education settings such as libraries and museums.
- The Institute helps NASA's Office of Space Science assist scientists in education and public outreach.
- Since 1978, LPI's Summer Intern Program has offered college undergraduates unique opportunities in planetary research.
- LPI's specialized library is a member of NASA's Regional Planetary Image Facilities for imagery and information.
- It houses a unique collection of imagery spanning planetary exploration from the Ranger missions to the Moon to the ongoing missions to Mars and the Jupiter and Saturn systems.
- LPI's staff and scientists work together to bring space science to the public and the education community in exciting and useful ways.

COMMERCIAL USES/PUBLIC BENEFITS

- Educational products from LPI offer well-tested materials for educators and science centers, museums, and planetariums.
- LPI provides information on the origin and evolution of solar systems, planets, and their satellites; asteroids; and meteorites.
- LPI's specialized library of planetary science information and imagery is available to the public.
- LPI offers teacher-training workshops regionally and nationally.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

College and Graduate Student Programs

Booth **971**

TECHNOLOGY CATEGORY: EDUCATION

DESCRIPTION

- JSC has a number of employment and educational opportunities designed for both undergraduate and graduate-level college students, including:
- The Cooperative Education Program and the Student Experiment Flights on the KC-135 zero-g aircraft
- The Education Training Cooperative and the Graduate Student Research Program
- The ACCESS (Achieving Competence in Computing, Engineering, and Space Science) and the NASA Scholars Programs
- The NASA Training Project and the SHPE-NASA Honors Program
- The Aerospace Medicine Project clerkships and the Oral History Project internships

COMMERCIAL USES/PUBLIC BENEFITS

- Student development programs may interest companies in contributing to the future success of students while accruing potential benefits from additional staffing support.
- The public benefits from these programs because students are inspired to seek degrees in the science and engineering fields.
- Students are encouraged to stay in school to further their education and gain practical work experience in their chosen major.

DEVELOPMENT STATUS: IN DEVELOPMENT

Distance Learning and Education Project
Electronic Classroom

Booth **971**

TECHNOLOGY CATEGORY: EDUCATION

DESCRIPTION

- JSC's DLEP delivers live, interactive learning experiences tailored to meet the educational needs of a wide variety of audiences.
- DLEP events are available to schools and informal educational facilities at no cost via H320 compatible videoconferencing systems.
- The DLEP classroom expeditions (learning modules) showcase the roles of science, mathematics, and engineering in human spaceflight, habitation, and exploration.
- The same technology that brings NASA to the classroom also provides unique communications opportunities for its own experts by linking them with colleagues and peers around the globe.
- And soon, astronauts living on the International Space Station will be learning while in orbit via onboard tools or linking with instructors or others on the ground.
- The Distance Learning Outpost at http://learningoutpost.jsc.nasa.gov is your starting point to learn more about K-12 classroom expeditions and other videoconferencing opportunities.

COMMERCIAL USES/PUBLIC BENEFITS

- This project enables universities and education organizations around the world to access JSC's vast resources.
- Educational and research partnerships with JSC can provide rich learning experiences for both students and faculty.
- Additionally, the project's resources are poised to meet new technologies and welcome the opportunity to test innovative distance learning program prototypes.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

A Diverse Workforce for Tomorrow's Technological Needs

Booth **969**

TECHNOLOGY CATEGORY: EDUCATION

DESCRIPTION

- JSC's Equal Opportunity Programs Office (EOPO) manages programs that expose all students - incuding students with disabilities - to careers in science, engineering, math, and other technological areas
- These programs ensure a skilled workforce that is capable of meeting tomorrow's technological needs.
- EOPO encourages JSC employees to mentor students in technical disciplines.
- EOPO strives to enhance our existing and future employees' skills by encouraging their sharing knowledge and excitement in technical disciplines.
- Grants are awarded to minority-serving institutions for both mission-related research and education partnerships.

COMMERCIAL USES/PUBLIC BENEFITS

- Workforce 2020 projects that minorities will constitute more than half of the net new entrants to the U.S. workforce in the early 21st century.
- Projections clarify the need for business and government to encourage all members of tomorrow's workforce to become technically capable.
- Approaches and programs EOPO uses will contribute to a workforce that is able to meet the technological challenges of the future.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

FIRST Robotics Competition

Booth **928**

TECHNOLOGY CATEGORY: EDUCATION

DESCRIPTION

- The FIRST (For Inspiration and Recognition of Science and Technology) Robotics Competition is a national engineering contest that immerses high school students in the world of engineering.
- Teaming up with engineers from government, businesses, and universities, students get a hands-on, inside look at the engineering profession.
- In six intense weeks every spring, students and engineers work together to brainstorm, design, construct, and test their "champion robot."
- The teams then compete in a spirited, no-holds-barred tournament complete with referees, cheerleaders, and time clocks.
- JSC sponsors the Clear Creek High School FIRST robotics team.

COMMERCIAL USES/PUBLIC BENEFITS

- Mentoring of high school students by professional engineers
- Promotion of the value of engineering, science, and technology disciplines to students

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Educators' Handbook

Booth **902**

TECHNOLOGY CATEGORY: EDUCATION

DESCRIPTION

- The Space Educators' Handbook is a space encyclopedia of technology and teaching resources.
- It has served as a resource for the JSC Scientific Advisor Program, Space Center Houston, and JSC Educational Services.
- The Space Educators' Handbook has been recognized nationally by USA TODAY, TEXAS MONTHLY, and other publications.
- The product is freely distributed to those requesting a CD-ROM by letter or accessing the web site.
- The Space Educators' Handbook is available on the JSC web site at "http://vesuvius.jsc.nasa.gov/er/seh/".

COMMERCIAL USES/PUBLIC BENEFITS

- An ideal tool for finding specific information related to industrial, university, and aerospace interests
- Marketing of the Space Educators' Handbook to public interests on a "non-exclusive" basis

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Teacher and Faculty Resources

Booth **971**

TECHNOLOGY CATEGORY: EDUCATION

DESCRIPTION

- JSC provides valuable resources for teachers and faculty members to enhance their ability to encourage students' interest in science, math, engineering, and technology.
- The Aerospace Education Services Program provides professional development workshops for teachers to enhance awareness and understanding of scientific research and technology.
- The Educator Resource Center provides expertise and facilities to help educators access science, mathematics, and technology instructional materials based on NASA's unique missions.
- The Summer Faculty Fellowship Program provides teaching faculty the opportunity to work at JSC on a ten-week project with support from a technical mentor.
- JSC's Teacher Workshops, including the NASA Education Workshop, provide teachers with direct interaction with NASA scientists, engineers, technicians, and education specialists.
- The Education Outreach Program and National Engineers Week provide teachers within a 50-mile radius with the tools to reach and inspire their students through the services of JSC volunteers.

COMMERCIAL USES/PUBLIC BENEFITS

- These resources are available to school systems, universities, teachers, and faculty members.
- Knowledge gained from JSC's technical pursuits is communicated within the education community to support the national education reform movement.
- Educators can reproduce and use educational print and Internet resources for their own education programs.
- Participants in education programs can meet and continue to communicate with other educators to develop collaborative projects.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Advanced Cryocoolers for Space Missions

Booth **G51**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- Cryocoolers are important for extended space missions because they can be used to liquefy propellants including O2, H2 and CH4.
- Pulse tube coolers are capable of reaching temperatures below 10 Kelvin.
- 3He and 3He/4He dilution coolers, capable of reaching temperatures below 0.05 Kelvin, can be used in microgravity research.

COMMERCIAL USES/PUBLIC BENEFITS

- Pulse tube coolers can be used in cell phone base stations, cryopumps, and MRI systems.
- Pulse tube coolers can also be used for cooling infrared detectors in space telescopes and Earth-observing satellites.
- Dilution coolers can be used to cool infrared and X-ray detectors and fundamental physics experiments in space.

DEVELOPMENT STATUS: IN DEVELOPMENT

Advanced Thermal Control Technology

Booth **G39**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- Active thermal control systems use pumped fluid loops to remove excess heat.
- Heat pipes boil and condense a fluid to move heat without using power.
- Carbon velvet and other methods can efficiently gather heat from its source.
- Lightweight radiator panels radiate the heat away.

COMMERCIAL USES/PUBLIC BENEFITS

- High-power electronic devices, including laptop computers
- More efficient methods of acquiring and rejecting heat

DEVELOPMENT STATUS: IN DEVELOPMENT

Batteries in Space—Yesterday, Today, and Tomorrow Booth **G42**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- Most battery requirements in the Mercury, Gemini, Apollo, Skylab, and Apollo-Soyuz programs were met by silver-zinc batteries.
- Non-rechargeable alkaline and new commercial rechargeable nickel-metal hydride and lithium-ion batteries provide many of today's equipment requirements in space.
- International Space Station requirements point toward multicycle rechargeable aerospace batteries: nickel-cadmium and nickel-hydrogen.
- A mix of all types is currently in use on the Shuttle and the Space Station in a wide variety of spacecraft and portable equipment.
- Batteries on the horizon for tomorrow's requirements are large lithium-ion, lithium-polymer, unique configurations of nickel-hydrogen, and even flywheels.

COMMERCIAL USES/PUBLIC BENEFITS

- Improved batteries in terms of increased ruggedness and safety
- Improved batteries in terms of reduced cost, weight, and volume
- Applications in cameras, camcorders, computers, cellular phones, tools, and electric vehicles

DEVELOPMENT STATUS: IN DEVELOPMENT

Flywheel Energy Storage System

Booth **927**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- FESS is an experiment to demonstrate that a flywheel system can replace the Space Station primary batteries.
- Each flywheel system will consist of two rotors, suspended on magnetic bearings, rotating in opposite directions in order to negate torque, and electronics to interface with the Station.
- Rotating at 60,000 rpm, each rotor will store 2.4 kW-hr of energy (4.8 kW-hr per system).
- The project will significantly increase the energy density of flywheel energy storage technology and will be a considerable cost and performance benefit for the Space Station.
- FESS will be integrated in an on-orbit solar array module to compare its operation in parallel with a battery system.
- Other FESS units will then replace battery systems on a battery end-of-life replacement schedule.

COMMERCIAL USES/PUBLIC BENEFITS

- Lighter weights and longer lifetimes than batteries
- Applications in the power distribution and automotive industries

DEVELOPMENT STATUS: IN DEVELOPMENT

In Situ Consumable Production

Booth **G41**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- ISCP involves acquiring, manufacturing, and storing propellants, fuel cell reagents, and consumables for life support using resources at the site of exploration.
- The chief benefits of ISCP are that it can reduce the mass, cost, and risk of robotic and human exploration by reducing launch mass, enhancing mission objectives, and increasing self-sufficiency.
- ISCP processes involve: 1) resource (atmosphere and regolith) collection and conditioning, 2) chemical processing and separation, and 3) reagent/product liquefaction, storage, and distribution.
- For Mars exploration, atmospheric carbon dioxide is processed with either Mars water or Earth-supplied hydrogen to produce oxygen, methane, methanol, and other hydrocarbon products.
- Processing hydrocarbon fuels for fuel cell power generation is also of interest for Mars robotic and human missions.

COMMERCIAL USES/PUBLIC BENEFITS

- Autonomous mining and farming
- Portable medical oxygen generators for home, airline, and military use
- Power generation and storage for automobiles and military
- Remote or distributed fuel production for farms and Third World countries
- Greenhouse gas reduction and conversion
- Technologies and infrastructure to enable space commercialization

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

International Space Station Power System Analysis Booth **G04**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- Determining how much power the International Space Station can generate is crucial to its operation.
- However, predicting power generation is difficult, since the Station is so large it cannot be completely assembled on the ground.
- Engineers at the NASA Glenn Research Center have developed a computer model called SPACE.
- SPACE is designed to accurately predict the performance of the Space Station power system under any operational condition.
- SPACE is one of the most highly integrated power system models ever developed.
- SPACE seamlessly combines solar array, battery, orbital mechanics, and power distribution models into an integrated package.

COMMERCIAL USES/PUBLIC BENEFITS

- Simulation of ground-based solar power systems
- Application of advanced technologies to existing power systems

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Nontoxic Reaction Control Systems for Reusable Spacecraft

Booth **G44**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- Nontoxic reaction control systems are critical to reducing cost and increasing safety by eliminating toxic propellants.
- Using nontoxic propellants can save 60%-80% (or $24M+) over the current state-of-the-art reaction control system on the Shuttle today and can improve the safety of ground and flight operations.
- This nontoxic system uses liquid oxygen and ethanol propellants that are pressure-fed to thrusters and ignited by spark.
- The technologies being developed for this nontoxic system are ignition systems, cryogenic insulation, dual thrust engines, and vacuum jacketed feedlines.

COMMERCIAL USES/PUBLIC BENEFITS

- Applications involving cryogenic insulation or ignition systems
- Launch vehicle and spacecraft industries

DEVELOPMENT STATUS: IN DEVELOPMENT

Photovoltaic Engineering Test Bed

Booth **927**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- The PET is a commercial laboratory for the calibration, measurement, and qualification of solar cells.
- Companies that manufacture solar cells will be able to use the PET to maintain calibrated standard cells and to measure efficiency and durability of the test cells in the space environment.
- The PET will be attached to the Japanese Experiment Module Exposed Facility (JEM-EF) on board the Internatinal Space Station.
- The PET on the JEM-EF will accommodate four replaceable trays, with each tray containing up to 16 sample coupons.
- The JEM-EF is equipped with a robotic arm and an airlock that will enable an astronaut inside the JEM pressurized module to place and remove the trays in the PET facility.

COMMERCIAL USES/PUBLIC BENEFITS

- Commercially competitive alternative to solar cell measurements taken by balloon or high-altitude aircraft
- Advances in the performance of solar cells and arrays

DEVELOPMENT STATUS: IN DEVELOPMENT

Power and Propulsion Technology

Booth **G04**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- Future space exploration will require safe, high-reliability, high-performance, and low-cost power and propulsion systems.
- Glenn Research Center's Power and Propulsion Project is working on the next generation of transportation concepts and power systems for human missions to Mars and beyond.

COMMERCIAL USES/PUBLIC BENEFITS

- The power and propulsion technologies developed have potential applications in automotive and electric utility industries.

DEVELOPMENT STATUS: IN DEVELOPMENT

Proton Exchange Membrane Fuel Cells

Booth **G43**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- A proton exchange membrane fuel cell electrochemically combines hydrogen and oxygen to produce electricity and a pure water by-product.
- These fuel cells are generally more efficient than power from conventional fossil fuel sources.
- They use a rugged solid membrane, low-cost cell materials, and a simple controller.
- Proton exchange membrane fuel cells offer significant benefits over other fuel cell technologies in terms of cost, power density, and life.

COMMERCIAL USES/PUBLIC BENEFITS

- A quiet, reliable power source for residential and commercial use
- Power with high fuel efficiency and low emissions
- Alternative to batteries in certain applications
- Applications include electric cars, locomotives, bicycles, boats, lawn mowers, landscaping tools, and power hand tools

DEVELOPMENT STATUS: IN DEVELOPMENT

Research in Magnetoplasma Propulsion

Booth **931**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- Magnetoplasma rocket technology consists of a high-power-density plasma rocket that is also capable of variable specific impulse.
- The system features a strong asymmetric magnetic field produced by high-temperature superconducting magnets.
- The propellant is typically hydrogen or helium.
- This technology enables very fast interplanetary transits (less than 130 days to Mars).

COMMERCIAL USES/PUBLIC BENEFITS

- This technolocy enables two-way access to geostationary orbits to service and repair the world's communication satellite network.
- It will also benefit space applications of superconductivity and the development of high-power compact equipment.

DEVELOPMENT STATUS: IN DEVELOPMENT

Solar-Powered Refrigeration

Booth **G39**

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- Solar-powered refrigeration systems are planned for use in hot environments in outer space.
- Solar photovoltaic power is used to directly power a refrigeration system compressor.
- Technologies such as vacuum insulation, smart controls, and phase change thermal storage lead to improved energy efficiency.
- NASA has developed and tested several devices using these technologies.

COMMERCIAL USES/PUBLIC BENEFITS

- Improved efficiency for refrigerators, freezers, and air conditioners
- Battery-free solar refrigerators
- Reduced oil consumption for commercial refrigerators/freezers

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Stennis Space Center Propulsion Systems Testing Booth G47

TECHNOLOGY CATEGORY: ENERGY SYSTEMS

DESCRIPTION

- SSC is NASA's lead center for rocket propulsion testing, principally for the Space Shuttle main engines.
- SSC is involved in testing for future space vehicles and is developing numerous technologies in support of propulsion systems.
- One such technology is acoustic monitoring and analysis, including acoustic impact on facility structures and vehicles.
- Heat flux radiometry and thermal imaging applications help to determine heat loads on various components.
- Exhaust plume spectroscopy, computational fluid dynamics and new designs for hydrogen burn-off igniters are also employed to improve engine design.
- A heads-up display system and a (fireman's) helmet-mounted camera system have been developed that help detect fire through smoke, fog, or mist
- Low-temperature sensors are also being evaluated for accuracy, response time, ruggedness, and maintainability.

COMMERCIAL USES/PUBLIC BENEFITS

- These technologies can be applied to any industry that deals in high-energy systems.
- Fire detection equipment can be applied to normal firefighting situations.

DEVELOPMENT STATUS: IN DEVELOPMENT

Advanced Lighting Technology

Booth **943**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- Dynamic, harsh sunlight conditions and adequate, reliable onboard lighting systems have significant impact on crew performance.
- We use an empirically based, computer-aided illumination modeling system to predict quantifiable visual performance in space.
- We have also developed tools to measure and evaluate luminaire performance.
- Material reflectance properties and luminaire performance are measured and integrated with computer models.
- We are evaluating new technology lighting systems with greatly extended lifetimes, such as solid-state lights, for general illumination of the International Space Station.

COMMERCIAL USES/PUBLIC BENEFITS

- Lighting analyses have applications wherever optimization of location, performance, and power may be required, including factories, secure areas, and public transportation.
- Solid-state illumination, with its improved reliability over conventional lights, is applicable for use in ships, airplanes, automobiles, and personal lighting systems.

DEVELOPMENT STATUS: IN DEVELOPMENT

Alertness Monitoring on the Flight Deck

Booth **527**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- This exhibit describes an automated system for monitoring pilot faces continuously and unobtrusively.
- The system processes percentage eyelid closure to assess pilot alertness.
- When percentage eyelid closure threshold levels are crossed, the system provides visual and auditory feedback.

COMMERCIAL USES/PUBLIC BENEFITS

- The device can be used to detect and manage hypovigilance in flight crews.

DEVELOPMENT STATUS: IN DEVELOPMENT

Anthropometry and Biomechanics Facility

Booth **943**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- The Anthropometry and Biomechanics Facility is equipped with state-of-the-art technology and equipment used to perform suit evaluations and understand human-hardware biomechanical issues.
- It also conducts studies to assess human functional strength capabilities in microgravity.
- Collaboration with private industry and academia is encouraged.

COMMERCIAL USES/PUBLIC BENEFITS

- The Facility's research data and methodologies have applications in many disciplines related to human factors, including strength, reach, and coordination.
- Biomechanics also has many applications in areas that deal with any kind of gear that is either donned or manipulated by humans.
- Some of the human performance issues dealt with in reduced gravity also have relevance to ground-based situations, such as people dealing with disabilities or extended bedrest.

DEVELOPMENT STATUS: IN DEVELOPMENT

Computer-Aided Human Factors Analysis

Booth **943**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- The Graphics Research and Analysis Facility uses high-performance computer technology to address human engineering issues in spacecraft design analyses and mission planning.
- Capabilities include lighting and viewing analyses, design concept visualization, human modeling, animation development, and virtual reality applications.
- Research activities include advanced inverse kinematics, improving task performance with luminence images, and extravehicular mobility unit strength and fatigue modeling.
- Analyses routinely determine optimal cameras and lighting for crew operations, preferred payload areas for safe extravehicular/intravehicular activity translation, and ideal restraint locations.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology can be used to optimize human performance and interfaces (i.e., automobiles, homes, factories), including human components such as vision, hearing, and strength.
- It especially has applications where human performance is crucial to safety, quality, and success.

DEVELOPMENT STATUS: IN DEVELOPMENT

Habitability Design

Booth **G27**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- Crews in orbit or on planetary surfaces have unique requirements for habitability hardware.
- The habitability design work done at JSC encompasses galley, wardroom, hygiene and crew quarters, medical, and exercise functional design areas.
- We employ human engineering and human factors considerations in design development.
- We also use software allowing three-dimensional visualization and animation for assessments and analysis.

COMMERCIAL USES/PUBLIC BENEFITS

- Development of virtual environments for training or educational use
- Design methodology and process development
- Human factors application for industry

DEVELOPMENT STATUS: IN DEVELOPMENT

Human-Centered Computing

Booth **G49**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- Research is being conducted on the work practices of scientists conducting fieldwork in a terrestrial analog of the Martian environment.
- This research will lead to the development of new tools and technologies for exploration in extreme environments, such as on the Moon and Mars.
- This research seeks to drive the design of information technologies from a user-centered or work practice perspective.

COMMERCIAL USES/PUBLIC BENEFITS

- Human-centered computing principles and insights can lead to improved user interfaces and better-designed products and technologies.

DEVELOPMENT STATUS: IN DEVELOPMENT

Interactive Systems

Booth **960**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- Gesture-based technology provides a new way to implement interactive kiosks.
- Such a kiosk has been developed to display Space & Life Sciences information on bioastronautics and astromaterials.
- JSC developed this project in partnership with Cybernet Systems Corp. via a Small Business Innovative Research grant.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology can be used in several commercial and military uses, including the banking and museum industries, or whenever automated interaction with the public is desired.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

International Space Station Russian Module

Booth **990**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- The self-guided exhibit contains a mockup of a Russian component of the International Space Station.
- View the technology involved in stowage configurations on board the Space Station and the stowage logisics required for spaceflight.

COMMERCIAL USES/PUBLIC BENEFITS

- The exhibit will help industry, business, educational institutions, and the general public to understand some of the benefits and techniques of using mockups.
- Mockups can be used to develop operational concepts or conduct feasibility studies resulting in both cost savings and safety.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Tactile Situation Awareness System

Booth **942**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- The TSAS takes advantage of the intuitive sense of touch.
- The TSAS provides redundant information to supplement or replace physiological signals.
- The TSAS is useful for navigation, communication, and alarms/indicators, and in training/simulation.
- It can be coupled with a broad array of sensors, including gyroscopes, global positioning satellite system, and inertial navigation.
- Advantages for special operations include novel representation of three-dimensional space, reduced information overload, using an unused sensory channel, and being a good alerting system.
- Benefits to NASA include instrumentation, space station construction/maintenance, situational awareness, and spatial orientation improvements.

COMMERCIAL USES/PUBLIC BENEFITS

- This excellent system for both commercial and private aviation increases situational awareness and prevents problems with spatial disorientation.
- It replaces unreliable seat-of-the-pants information with real-time correct spatial information.
- Commercial applications are considerable, ranging from robotics to providing a prosthetic for the sensory handicapped and patients who have lost vestibular function or are recovering from ear surgery.
- The TSAS will be important to the Department of Defense for aviation, friend or foe recognition, orientation during diving, and situational awareness of high-performance weapon platforms.
- The TSAS will also aid in improved man-machine interface, improve the ability to spatially track targets, and reduce information overload.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Usability Testing

Booth **943**

TECHNOLOGY CATEGORY: HUMAN FACTORS

DESCRIPTION

- Usability testing is a formal process for evaluating equipment intended for use by humans.
- Researchers conduct systematic tests to see how equipment is actually used in a wide range of situations.
- Results identify problems - and sometimes benefits - the designers did not anticipate.
- Usability testing of foot restraints for use in zero gravity is shown as an example.

COMMERCIAL USES/PUBLIC BENEFITS

- Any product that involves human use of equipment or software benefits from usability testing.
- Usability testing identifies unanticipated pros and cons of a given design, sometimes preventing dangerous or costly mistakes.
- It helps ensure that switches, buttons, and other controls can be manipulated as expected and produce the desired effects when used by the customer for the first time.

DEVELOPMENT STATUS: IN DEVELOPMENT

Antennas and Applied Computational Electromagnetics

Booth **G10**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- The exhibit displays antenna designs for various applications.
- The exhibit also displays recent advances in computational electromagnetics.
- These advances focus on techniques to solve larger problems with less computer capacity and/or an increased level of accuracy.

COMMERCIAL USES/PUBLIC BENEFITS

- Terrestrial microwave communications
- Biomedical pursuits, including computational electromagnetics applied to millimeter wave angioplasty analysis
- Antenna and radio-frequency component research and development

DEVELOPMENT STATUS: IN DEVELOPMENT

Chemical Sensor Microsystems

Booth **G04**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- Supported by Glennan Microsystems Initiative (GMI), Glenn Research Center is developing numerous smart microsystems for operation at high temperatures.
- GMI's mission is to commercialize microelectromechanical systems for harsh environments.
- GMI's microfabricated hydrogen sensor detects 1% Hydrogen in inert and air environments.
- The hydrogen sensor unit has been tested successfully on two Space Shuttle missions and is scheduled for use on X-33, X-43, and the International Space Station.

COMMERCIAL USES/PUBLIC BENEFITS

- These microsystems provide advanced lightweight, batch-fabricated sensors for aeronautics, space transportation, auto industry, numerous manufacturing processes, and environmental applications.
- Ford Motors used the hydrogen sensor to leak check the natural gas-powered Crown Victoria car.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Compact Microscope Imaging System

Booth **G04**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- The CMIS is a miniature machine vision system that combines intelligent image processing with remote control capabilities.
- This system can scan, find areas of interest, focus, and acquire images automatically.
- CMIS is a diagnostic tool with intelligent controls for use in space, industrial, medical, and security applications.

COMMERCIAL USES/PUBLIC BENEFITS

- CMIS can help monitor dendrite growth, colloid science, and protein and zeolite crystal growth.
- It can be used to track colloid/fluid behavior and flow details.
- CMIS can benefit soil mechanics experiments (including lunar and Martian experiments).
- It can follow protein crystal growth.
- CMIS can enhance surface exploration.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Detection of Buried Metallic and Nonmetallic Objects

Booth **G09**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- A microwave system for detecting nonmetallic (plastic) buried objects has been developed.
- An adaptive nulling magnetic coil sensor for detecting metallic objects has also been developed.
- These systems can detect landmines, plastic pipes, and layer (tier) thicknesses.
- Also included is a three-dimensional locator/imaging system for data stacking and target enhancements.

COMMERCIAL USES/PUBLIC BENEFITS

- Humanitarian de-mining efforts of plastic/metal antipersonnel mines
- Locating buried plastic pipes and fiber-optic lines that are put in plastic pipes

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Global Positioning Satellite System Applications

Booth **G33**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- GPS is a 24-satellite network that provides users with position, velocity, time, and, potentially, attitude information.
- NASA is using GPS on the Space Shuttle, Space Station, crew return vehicle, and in other programs.
- This exhibit shows GPS hardware and describes GPS' various applications within NASA.

COMMERCIAL USES/PUBLIC BENEFITS

- Farming, mining, surveying
- Navigation of ships and airplanes
- Using GPS for attitude is still an emerging technology; NASA is working with the Port Authority of Houston

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Integrated Vehicle Health Management

Booth **G23**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- IVHM includes the total integration of flight and ground vehicle health monitoring elements.
- The three elements of flight IVHM are advanced sensors, distributed data acquisition architecture with high-density/solid-state mass storage, and extensive real-time data processing.
- The two elements of ground IVHM are evolved control room architectures with advanced applications and automated ground processing systems for servicing checkout.
- 2.

COMMERCIAL USES/PUBLIC BENEFITS

- IVHM has direct applications in the automotive and aircraft industries.
- It also has applications for equipment maintenance in any industrial setting.

DEVELOPMENT STATUS: IN DEVELOPMENT

Laser Dynamic Range Imager

Booth **929**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- The LDRI produces video images as well as distance or range information for everything that is visible in the image.
- It produces three-dimensional information from one camera.
- The LDRI updates the video 30 times per second and the range 7 times per second.
- This system will measure the motion (or vibration) of large flexible components on the International Space Station.
- This information will be used to verify that computer predictions of the motion are correct.
- The LDRI can also be used as a light source, a night-vision camera, a navigation sensor, a robotic vision sensor, a structural inspection tool, and a shape/terrain mapper.

COMMERCIAL USES/PUBLIC BENEFITS

- Production of three-dimensional effects in real time for filmmakers and video game developers
- Three-dimensional models of motion for sports training and medical analysts applications
- Recording, analyzing, and monitoring the motions of large structures
- Collision warning and navigation for automobiles, trucks, trains, and airplanes
- Three-dimensional images to document accidents/disasters for insurance industry investigators
- Quality and production control systems
- "Smart" robots with three-dimensional vision

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Micro-Wireless Instrumentation System

Booth **929**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- The micro-wireless instrumentation system includes autonomous, micro-sized temperature sensors/transceivers and a data acquisition system for space and ground applications.

COMMERCIAL USES/PUBLIC BENEFITS

- Wireless structural and thermal test instrumentation
- "Fly-by-wireless" aircraft and ground transportation systems
- Wireless thermostat and home monitoring/management systems

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Microelectromechanical Systems for Advanced Navigation

Booth **G45**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- Microelectromechanical systems are mechanical devices that are 1 to 1000 microns in scale.
- JSC is working with vendors to develop microelectromechanical system angular rate sensors for spacecraft navigation.
- These rate sensors show considerable promise for reduction in size and power with comparable performance to traditional sensors.
- JSC is pursuing integration of microelectromechanical system rate sensors with other navigation sensors, such as global positioning satellites.
- Applications will include microsatellites, whose low cost has the potential to revolutionize many space missions.
- Microelectromechanical systems are batch fabricated using processes originally developed for the integrated circuit industry.

COMMERCIAL USES/PUBLIC BENEFITS

- Low-cost, microsatellite chassis for commercial or educational uses
- Transportation tracking applications
- Platform stabilization and motion sensing for the electronics industry

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Microwave Sensors for Ice Detection on Aircraft

Booth **G07**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- Microwave sensors detect ice as it transitions from water to ice or ice to water.
- Electronics sense the phase change (water to ice or ice to water).
- The system employs small ice sensors at multiple locations to cover large areas such as aircraft wings.

COMMERCIAL USES/PUBLIC BENEFITS

- Airline industry - to aid pilots during takeoffs in freezing conditions
- Determining the presense of water in closed-loop gaseous systems

DEVELOPMENT STATUS: IN DEVELOPMENT

Silicon-Carbide Devices for High-Temperature Operation

Booth **G04**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- Supported by Glennan Microsystems Initiative (GMI), Glenn Research Center is developing silicon-carbon microelectronics for operation at high temperatures.
- GMI's mission is to commercialize microelectromechanical systems for harsh environments.
- Several of GMI's electronic components and packaging materials have operated successfully at 600 C.

COMMERCIAL USES/PUBLIC BENEFITS

- These devices provide advanced electronics for aeronautics, space transportation, auto industry, numerous manufacturing processes, and biomedical applications.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Ultraviolet/Infrared Hydrogen Flame Detector

Booth **G23**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- The ultraviolet/infrared hydrogen flame detector is a multispectral, digital-signal-processing-driven flame detector.
- It was developed to reliably sense flame from many sources caused by the ignition of hydrogen gas, including a small hydrogen flame.
- The design incorporates in a single enclosure all the components needed for the fire detection.
- The flame detector is immune to false alarm situations by detecting attributes that are characteristic of an actual flame while rejecting characteristics from flame reflections or scattered light.
- The detector allows distant hydrogen flames (such as the large flare stack that is continuously lit during Space Shuttle fueling operations) to be rejected, while detecting flame in its alarm zone.

COMMERCIAL USES/PUBLIC BENEFITS

- The detector has direct applications in the petrochemical, aviation, and aerospace industries.
- It could also be used by research laboratories and gas manufacturers.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Universal Mini-Controller

Booth **G08**

TECHNOLOGY CATEGORY: INSTRUMENTATION

DESCRIPTION

- The universal mini-controller is a high-performance, low-power, rugged-environment computer in a compact, industry-standard form factor.
- Additionally, it offers large memory, small size, and extensive input/output.

COMMERCIAL USES/PUBLIC BENEFITS

- For use in rugged situations, including on the factory floor, in aircraft, in mines, on trains, aboard ships, for traffic light control, automatic teller machines, and in power plants
- For automation, robotics, process control, vehicle control, or system management

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Advanced Machining of Complex Spacecraft Parts Booth **104**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- JSC's high-speed machining center enables increased capacity for manufacturing large, complex parts.
- Computer-generated models are programmed and downloaded directly into the machine.
- The machine provides full 5-axis contouring of parts up to 157 x 93 x 39 inches.
- Interchangeable heads allow quick conversion from conventional to high-speed machining.
- High-speed machining allows higher material removal rates, lower cutting forces, and smoother surface finishes.
- High-speed machining of some materials requires no coolant due to the efficient release of cutting energy to chips.
- Virtual tool path simulations are performed to reduce rework and scrap rates.

COMMERCIAL USES/PUBLIC BENEFITS

- JSC is beta testing the machine with the Cincinnati Machine Company.
- The test results will be used to improve the product for future customers of this U.S. manufacturer.
- The use of this equipment to perform jobs for unique or specialized machining will be discussed on a case-by-case basis.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Composites Manufacturing

Booth **9S6**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- JSC develops and designs composite structures.
- Key challenges include the integration of tool development early in the design process as well as the use of prepregs, wet lay-up, and resin transfer molding techniques.
- Facility capabilities include two autoclaves, resin transfer molding equipment, ultrasonic nondestructive evaluation equipment, a 5-axis router, and material testing equipment.
- This exhibit features an operating 5-axis router.

COMMERCIAL USES/PUBLIC BENEFITS

- Lighter, stronger, and stiffer materials for aerospace, marine, architectural, medical, and sporting goods applications
- Fatigue-resistant materials for mechanical and civil engineering applications

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Friction Stir Welding

Booth **104**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- Friction stir welding is a new, solid-state method of fusion joining metallic and metallic composites.
- This process combines the metallurgical complexities of arc welding with the reliability and simplicity of machine tool technology.
- Using a specially shaped rotating tool, full penetration fusion welds are possible.
- Ferrous and non-ferrous alloys are weldable, including dissimliar alloys and previously "unweldable" alloys.
- Key benefits of friction stir welding are higher as welded mechanical properties, low distortion and warpage, and very low defect rates.

COMMERCIAL USES/PUBLIC BENEFITS

- Welding alloy fuel tanks, automotive structural components, and large, thin components
- Shipbuilding and marine industries
- Railway, land transportation, construction, and the electrical industries

DEVELOPMENT STATUS: IN DEVELOPMENT

Laser Tracker

Booth **2204**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- JSC uses a three-dimensional laser tracker system to inspect large, complex vehicle structural components.
- This technology generates a precise "as-built" computer model of the inspected part, which we can then compare to the computer-aided design model created by the design engineers.
- This electronic inspection process has reduced the inspection time and effort by 70%.
- This tool also allows us to align the large structural components to meet precise assembly requirements.

COMMERCIAL USES/PUBLIC BENEFITS

- This system allows very precise inspection and alignment of large, complex structural components.

DEVELOPMENT STATUS: IN DEVELOPMENT

Manufacturing High-Precision Miniature Components Booth **102**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- The Miniature Manufacturing Laboratory (MML) uses conventional and advanced manufacturing processes and packagining technologies to create unique, minature mechanical prototype parts and assemblies.
- MML capabilities include conventional and computer-numerical-controlled milling, turning, laser machining, and welding.
- Customers for MML services require the manufacturing of unique, high-precision, miniature parts for concept and engineering evaluation.

COMMERCIAL USES/PUBLIC BENEFITS

- Manufacturing of miniature parts or assemblies for industry, business, or education

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Manufacturing Technologies: From Design Through Delivery

Booth **101**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- This exhibit illustrates a manufacuring process from design through delivery of a product to the customer.
- First, we show designing in a collaborative environment.
- Next, we demonstrate off-line programming for manufacturing.
- Then we simulate virtual manufacturing and virtual assembly.
- Finally, we perform verification of the manufacturing process for the part and/or system.
- Through this process, we demonstrate how all design data and associated documentation is translated into an engineering model.

COMMERCIAL USES/PUBLIC BENEFITS

- Increasing collaboration within the design process
- Quicker turnaround time to produce an engineering model of a part or system
- Redefining the business model from designing the part and/or system to the delivery of the product to the customer

DEVELOPMENT STATUS: IN DEVELOPMENT

Manufacturing Technology Tour

Booth **9S5**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- This tour will illustrate the diversity of manufacturing technologies in use and under development at JSC for manufacturing spaceflight-related products.
- Manufactured products range in size from large spacecraft structural elements to miniature components.
- Manufacturing technologies include large, five-axis machining (milling); standard-size machining (milling, turning, electrical discharge machining); and miniature machining (milling and turning).
- Also included are technologies for sheet metal and welding fabrication; water jet cutting; soft goods fabrication; and electronic assembly.
- Manufacturing technology development is required to reduce space hardware manufacturing costs, save vehicle weight, and decrease design-to-manufacturing time.
- Our goal is to provide a manufacturing environment for the research, development, and manufacturing of space-related hardware of all size extremes.

COMMERCIAL USES/PUBLIC BENEFITS

- Improved manufacturing techniques can lead to higher quality products and decreased cycle time, contributing to cost savings in business.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Measurement Standards and Calibration Laboratory Booth **9S9**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- The Measurement Standards and Calibration Laboratory provides automatic calibration capabilities.
- As a demonstration, a computer-controlled, multifunction calibrator calibrates a precision digital multimeter with minimal operator intervention.
- The software generates calibration reports that provide the results of the tests.

COMMERCIAL USES/PUBLIC BENEFITS

- Reduced time for calibration
- Removal of human error from the calibration process

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Printed Circuit Board Rapid Prototyping

Booth **9S1**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- CircuitWriter is a multilayer, printed circuit board rapid prototyping system.
- It can fabricate printed circuit board designs from standard computer-aided design output files, usually within one day, depending upon size and complexity.
- CircuitWriter's two-step manufacturing process consists of machining a base panel substrate and then extruding conductive polymer traces.
- These printed circuit board prototypes are produced quickly and at a lower cost as compared to a high-volume printed circuit company.

COMMERCIAL USES/PUBLIC BENEFITS

- Providing an alternative to traditional breadboarding of prototype circuitry
- Reducing the high cost of quick turnaround circuit board prototyping during the development phase

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Virtual Manufacturing at JSC

Booth **103**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- Virtual manufacturing allows us to fully simulate the entire manufacturing cycle before any physical processes are initiated.
- This exhibit demonstrates state-of-the-art virtual simulations for manufacturing.
- These simulations can be used to verify the parts program before material is cut.
- Simulations increase the level of confidence that parts will be manufactured according to the design specifications.
- Simulations help to reduce scrap as well as to decrease the “concept to customer” cycle time.

COMMERCIAL USES/PUBLIC BENEFITS

- Verifies manufacturing processes while still in the planning stages
- Reduces cost to produce hardware

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

X-38 Project—Prototyping the Space Station Crew Return Vehicle

Booth **2201**

TECHNOLOGY CATEGORY: MANUFACTURING

DESCRIPTION

- The X-38 is using prototype and rapid development techniques to develop and test the design of the CRV for the International Space Station.
- The Station crew would use the CRV in an emergency to return to Earth when the Shuttle is not docked.
- On display are atmospheric flight test vehicle V-132 and spaceflight test vehicle V-201.
- V-132 has been retired after 3 sucessful flight tests at Dryden Flight Research Center in California.
- V-201 is being prepared for a Shuttle spaceflight test in 2002.
- Other key technologies displayed include laser optic inspection, computer-aided design and manufacturing of components, and advanced composite patterns, molds, and parts.

COMMERCIAL USES/PUBLIC BENEFITS

- Enhanced techniques for design of hardware or software projects

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Applications of Single-Walled Carbon Nanotubes

Booth **9S3**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- The overall goal of this Phase II SBIR (Small Business Innovative Research Grant) program is to develop high-performance electrochemical capacitors (ECs) based on carbon nanotubes.
- An EC is an electrical storage device capable of delivering nearly 100 times the power of conventional batteries and demonstrating long operational lifetimes.
- For NASA applications, ECs will typically be used in combination with a battery to provide extended bursts of power.
- This combination results in substantial power enhancement combined with significant weight and volume savings.
- The use of carbon nanotubes in ECs offers a number of advantages including high power capacity, low weight, and good conductivity.
- ReyTech Corporation scientists have developed methods to significantly improve the electronic storage properties of carbon nanotubes nearly tenfold through proprietary methods.
- Prototype ECs based on these materials have been fabricated and are being tested for targeted NASA applications.

COMMERCIAL USES/PUBLIC BENEFITS

- ECs will find numerous applications in the aerospace industry where high peak powers and sustained energy are required.
- Commercial applications for consumer electronics include video cassette recorders and cameras, audio systems, cellular phones, and a variety of portable electronic devices.
- Computer applications include startup power for laptops, SRAM, sequence controllers, and computer bridge.
- Hybrid vehicle applications include actuators (valve control, electric windows, auto door locks, air bag deployment), electrical power steering, and engine start.
- ReyTech Corporation is seeking private/governement support for commercial development of this enabling technology.

DEVELOPMENT STATUS: IN DEVELOPMENT

Carbon Nanotubes

Booth **9S2**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- Carbon nanotubes are 10-100 times stronger than steel at 1/6th the weight.
- Nanotubes are 1/50,000th the diameter of a human hair, or approximately one nanometer wide.
- JSC produces nanotubes using both laser and arc processes.
- These nanotubes are purified using acid treatment and chemical and heat treatment processes.
- The focus at JSC is to use nanotubes in applications such as high-strength composites and thermal management materials.
- Other NASA Centers are working on applications such as nanoelectronics and sensors.

COMMERCIAL USES/PUBLIC BENEFITS

- Wide variety of possibilities in industry, based on nanotube mechanical, electrical, and thermal properties
- Energy storage devices
- Flat panel displays
- Electronics (Eventually, nanoelectronics using carbon nanotubes could replace today's microchips.)

DEVELOPMENT STATUS: IN DEVELOPMENT

Fracture Control and Nondestructive Evaluation

Booth **9S8**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- Fracture control and nondestructive evaluation are used to prevent catastrophic failures resulting from crack defects in structural components.
- The methodology is similar to that used for preventing failure of critical structures in civil and military aircraft.
- JSC is making significant advancements studying crack growth behavior in materials, through nondestructive evaluation, and by developing analysis software.
- NASGRO is the standard NASA software used for fracture control analysis.

COMMERCIAL USES/PUBLIC BENEFITS

- Aircraft, petrochemical, offshore oil production, railroad, nuclear, and automobile industries

DEVELOPMENT STATUS: IN DEVELOPMENT

JSC Receiving, Inspection, and Test Facility

Booth **G31**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- The JSC Receiving, Inspection, and Test Facility does mechanical and chemical testing, including optical emission spectroscopy, tensile, hardness, and microhardness testing.
- The Facility also performs electrical, electronic, and electromechanical component failure analysis, destructive physical analysis, screening, and evaluations.
- Personnel conduct wire and cable screening and testing, including 100% insulation integrity screening.
- They also train others for fabrication and inspection skills in through-hole soldering, surface mount device technology rework, fiber optic termination, cable harnessing and crimping, and conformal co

COMMERCIAL USES/PUBLIC BENEFITS

- The Facility has some excess testing and analysis capacity, which private industry could use.
- Specialized equipment such as the optical emission spectrometer, the emissions microscope, and real-time X-ray unit may provide capabilities not readily available to the commercial industry.
- The training conducted in the Facility could benefit companies unable to find such specialized training elsewhere.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Materials International Space Station Experiment Booth **927**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- The MISSE is a reflight of two reusable passive experiment containers (PECs) previously flown on the Russian Space Station Mir.
- Astronauts deploy PECs during extravehicular activity and attach them to an exterior handrail with a clamp/pointer assembly.
- A PEC contains various passive sample trays, carousels, and plates, as well as vacuum ultraviolet diodes, and an atomic-oxygen pinhole camera.
- Spacewalking crewmembers open the PEC to expose experiments on opposite sides and orient it to view Ram/Wake.
- The PEC experiment specimens are passive and have no power, data, thermal, or maintenance requirements.
- The PEC units will be attached to select locations on the International Space Station and exposed to the space environment for a period of one to three years.

COMMERCIAL USES/PUBLIC BENEFITS

- Development of new materials

DEVELOPMENT STATUS: IN DEVELOPMENT

Materials Testing

Booth **9S7**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- Routine materials tests identify tensile strength, hardness, fracture toughness, and fatigue crack growth.
- JSC uses energy-dispersive spectroscopy to identify metals.
- Gas chromatograph/mass spectroscopy and Fourier Transform infrared analyses are used to identify non-metals.
- For corrosion-sensitive applications, the Center also conducts corrosion, stress corrosion, humidity, and fluid compatibility tests.
- During the hardware development stage, the most important consideration is to test materials in the environments to which they will be exposed in-service.

COMMERCIAL USES/PUBLIC BENEFITS

- Characterizing properties for newly developed materials
- Comparing materials properties to help select materials for a given application
- Determining how a specific hardware piece will react in the expected service environment

DEVELOPMENT STATUS: IN DEVELOPMENT

Safety, Reliability, & Quality Assurance's Role in Micro/Nano Technology

Booth **G31**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- SR&QA at JSC is concerned with the infusion of new and advanced technologies in human spaceflight.
- To that end, SR&QA sponsors several projects in advanced technology infusion, nanotechnology/nanoscience, and microtechnology/microelectrical mechanical systems.
- We are working on the infusion of advanced sensor technology in the ground-based and on-orbit detection of hazardous contaminants, such as hydrazine gas.
- We are also looking at the potential biological effects, toxic or otherwise, of new nanomaterials and processes, as well as being involved in quality assurance in that field.
- SR&QA is involved in applications of carbon nanomaterials/nanocomposites in human and electronics space radiation shielding and protection countermeasures.
- SR&QA also supports advanced biotechnology infusion in the areas of Habitation/Safety Lighting, Noise Exposure, and Nanomedicine.

COMMERCIAL USES/PUBLIC BENEFITS

- The applications of these advanced technologies and materials will have significance in medical and clinical diagnostics and in environmental sensing.
- It will also enable smaller, faster, and more reliable electronics for vehicle and transportation engineering.
- These are just a few of a wide variety of beneficial uses for consumers.

DEVELOPMENT STATUS: IN DEVELOPMENT

Single-Wall Carbon Nanotube Technology

Booth **9S4**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- A carbon nanotube is a cylindrical molecule of carbon, containing millions of carbon atoms.
- These individual molecules have tensile strength 100 times that of steel and they conduct electricity and heat very well.
- NASA is supporting research in production and applications of single-wall carbon nanotubes at Rice University.

COMMERCIAL USES/PUBLIC BENEFITS

- High-toughness and -strength fibers and composite materials
- Conductive polymers and new electronic applications
- Cold cathodes, filters, sensors, and transducers

DEVELOPMENT STATUS: IN DEVELOPMENT

Space Vacuum Epitaxy Center Commercial Product Development

Booth **G01**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- The Space Vacuum Epitaxy Center was established in 1987 as a NASA Commercial Space Center.
- It conducts materials processing research and development in laboratories at the University of Houston and in space aboard the Wake Shield Facility.
- The Center collaborates with other NASA research centers, industry, and universities worldwide to identify the need for novel materials and devices.
- Using thin film growth technologies (epitaxy), the Center is creating the next generation of semiconductor and superconductor materials, focusing on eventual commercial applications.

COMMERCIAL USES/PUBLIC BENEFITS

- The Center's nitride materials research promises implantable glucose monitors for diabetics.
- Mid-infrared solid-state lasers will offer compact and noninvasive biological and chemical sensors for medical and industrial applications.
- High-efficiency solar cell material is being developed that will greatly reduce the size of solar panels for both terrestrial and space uses.
- Thick film superconducting wire is being produced that will save energy lost during distribution and cut consumer utility costs.

DEVELOPMENT STATUS: IN DEVELOPMENT

Structures and Materials Technology for NASA Space Programs

Booth **517**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- New advances in materials and structures are being made at Langley Research Center.
- We are developing lightweight carbon fiber reinforced composites that have higher operating temperatures than current state-of-the-art composites.
- These new composite materials will lead to lighter vehicles by allowing aerospace structures to operate at higher temperatures, thereby reducing the thermal protection.
- New “smart materials” have the potential to sense their environment and react to changing performance requirements by altering their properties and shape.

COMMERCIAL USES/PUBLIC BENEFITS

- Many of these technologies can be applied to increase safety, reduce cost, and improve performance of air travel for the general public.

DEVELOPMENT STATUS: IN DEVELOPMENT

Thermal Protection Systems

Booth **G48**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- Space Shuttle thermal protection systems use extremely lightweight, low-thermal-conductivity materials.
- Ames has "one-stop shop" capabilities for thermal protection system work, including arc jets, materials processing, development labs, and computational fluid dynamics analysis.

COMMERCIAL USES/PUBLIC BENEFITS

- Applications of thermal protection system technology include automotive insulation, high-temperature microsensors, furnace liners, firefighter survival tents, and bone implants.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

TransHab

Booth **941**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- The TransHab inflatable module is a new concept proposed for the International Space Station.
- The design provides large-volume, inflatable living quarters.
- Launched in the volume of a traditional module, it provides three times the living space on orbit.
- TransHab combines a hard central core with an inflatable exterior shell.
- A unique layering of elements in the shell provides meteoroid orbital debris protection.
- The technology has been pressure tested to a safety factor of four.
- A full-scale test article was tested in vacuum for deployment and inflation to full pressure.

COMMERCIAL USES/PUBLIC BENEFITS

- Technology of inflatable structures
- Habitation in hostile environments
- Protection against orbital debris
- Applications that combine a highly stressed "soft" material with a rigid structure
- Portable hyperbaric chambers/submarine crew rescue

DEVELOPMENT STATUS: IN DEVELOPMENT

Water-Based Electroactive/Conducting Polymers Booth **G23**

TECHNOLOGY CATEGORY: MATERIALS

DESCRIPTION

- This technology uses template polymerization for waterborne conducting systems.
- Developed at the University of Arkansas with funding from Kennedy Space Center, this method is inexpensive and environmentally safe (using water rather than organic solvents).
- It increases the water solubility and processability of electrically conducting polymers.
- The resulting polymers can be used in applications such as electronics, antistatic coatings, corrosion prevention, photolithography, and electromagnetic interference shielding.
- The technology requires less energy in processing than metals and semimetals and uses by-products of papermaking that are readily available and inexpensive.

COMMERCIAL USES/PUBLIC BENEFITS

- Targeted commercial uses are corrosion prevention, antistatic coatings for fabrics, electronics and stealth technology, and high-temperature-conducting adhesives.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Ada-Pine Software Test Coverage Tool for Ada Programs

Booth **G37**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- Ada-Pine was developed under software research funding.
- It provides control flow analysis, unit-based code inspection, and instrumentation to support test coverage analysis of Ada software programs.
- Ada-Pine supports testing during software development, integration, testing and maintenance, as well as integrated static and dynamic analysis for Ada programs.
- The tool is also user-friendly and employs a Windows graphical user interface.

COMMERCIAL USES/PUBLIC BENEFITS

- This tool may be used by anyone developing or maintaining Ada software.

DEVELOPMENT STATUS: IN DEVELOPMENT

Cockpit Avionics Prototyping Environment

Booth **3004**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The cockpit avionics prototyping environment provides a mechanism for reducing the time from idea concept to operational deployment in a flight cockpit.
- It supports the cockpit avionics upgrade activities for the Shuttle Program.
- Astronauts use the prototyping environment as a tool for ascent/entry training to execute many phases of a Shuttle mission in an office setting.

COMMERCIAL USES/PUBLIC BENEFITS

- The environment is available as an easy-to-use Shuttle flight simulator.
- The environment and concepts can reduce the time needed to deliver an operational system to a customer.

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

DIRECT Coupled Loads Software

Booth **G30**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The DIRECT software program greatly simplifies the computations required to predict loads and stresses for a system with two or more structures coupled together.
- The program has an efficient way to run multiple load predictions for one structure with multiple structures attached to it.
- It also allows for quick assessments of design changes for a new structure attached to an existing structure.

COMMERCIAL USES/PUBLIC BENEFITS

- Aircaft, automotive, ship, bridge, and offshore platform design

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Electronic Auxiliary Power Unit

Booth **929**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The EAPU is one of the primary safety upgrades under consideration for the Space Shuttle.
- The auxiliary power units are generators that power the Shuttle's hydraulics.
- Today, those generators use a highly volatile and toxic rocket fuel - hydrazine.
- Electric motors, powered by a bank of lightweight batteries, will be developed to power the Shuttle's hydraulic system.
- This will provide a greater reliability for astronauts in flight and a safer workplace for ground crews.

COMMERCIAL USES/PUBLIC BENEFITS

- The development of the EAPU components and batteries could have applications for other aerospace industries and automobiles.

DEVELOPMENT STATUS: IN DEVELOPMENT

eSim - Internet-Based Simulation

Booth **G38**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- eSim enables the deployment and distribution of simulations via the Internet.
- Using eSim, one can set parameters, execute, and view results of any simulation using a browser.
- eSim-i delivers an interactive eSim capability, i.e. one can change simulation parameters and observe the results in real time.
- eSim provides a method for secure and authorized access to simulations without access to source code or computational facilities so that intellectual property is protected.
- HTML documents serve as point-and-click graphical user interface for the eSim deployed simulation/simulator.
- eSim is a software architecture and software tool suite for Internet-based simulation using a client/server construct.

COMMERCIAL USES/PUBLIC BENEFITS

- Training simulators can be run from anywhere at any time via the Web
- Reduced cost for distributing and maintaining simulations for many users at many sites
- Reduced potential errors caused by multiple versions of simulations or miscommunication among developers
- Educational outreach by providing access to selected simulations for the educational community
- Feedback from customers by collecting usage and interest data
- Application Service Provider, i.e. offer customers the ability to use simulations over the Internet for a fee

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Hazardous Gas Safety—Technology Infusion, Application, and Assurance

Booth **G31**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- Hydrazine is a highly toxic compound currently used in aerospace propulsion and power systems for Shuttle and Station.
- Current hydrazine detection methods aboard the Space Shuttle use the highly unreliable and nonspecific Drager tubes.
- The Safety, Reliability, & Quality Assurance group has initiated a study to find solutions for improving the gas-monitoring system.
- These advanced microelectrical mechanical system (MEMS)-based detection devices are in the mature to engineering prototype stages.
- MEMS devices include: Jet Propulsion Laboratory miniature mass spectrometer, Kennedy Space Center colorimetric dosimeter badge, and Glenn Research Center MEMS-based chemical gas detector system.
- White Sands Test Facility gold salt hydrazine indicators and the AFRL/Aerospace Corporation fiber optic hydrazine dosimeter are also MEMS devices.

COMMERCIAL USES/PUBLIC BENEFITS

- The research on MEMS-based hydrazine sensors can lead to lower cost and miniaturization.
- Smaller, low-power, low-cost sensors enable many detection points to be used within a chosen volume.
- They also have more potential for integration with clothing, or as handheld devices, which would aid in detection of contamination before entering a facility and in inspection and screening.

DEVELOPMENT STATUS: IN DEVELOPMENT

Integrated Design Center

Booth **G03**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The IDC is a facility designed to expedite JSC's engineering design process.
- It allows engineers at JSC and across NASA to make major improvements in the quality and timeliness of collaborative projects.
- The IDC is also being used to prototype distance learning techniques within the education community.

COMMERCIAL USES/PUBLIC BENEFITS

- Collaborative technologies and processes that enable industry to better communicate among their customers and suppliers
- Pooling of expertise from across the country to work jointly on complex projects
- High school and middle school students' access to subject matter experts anywhere in the world without leaving their classroom

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

International Space Station Program Knowledge Management

Booth **924**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The International Space Station is the most complex endeavor ever attempted by humankind and many of the operations concepts are new and different.
- As more experience is gained with living and working onboard the Station, there will be an ever-expanding set of lessons learned and changes to be made.
- A process and software has been developed that records, verifies, distributes, and ensures implementation of lessons learned for the Space Station Program.

COMMERCIAL USES/PUBLIC BENEFITS

- Taking advantage of lessons learned has clear applicability in business and industry.
- Large companies benefit by maintaining a knowledge base from project to project.
- Recurring injuries and hardware damage can be prevented.
- New concepts and processes are documented as they occur and can be quickly distributed to other areas within a business.
- When all the work is done, the final product is an excellent training tool for employees.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Internet Project Engineering Management Tools

Booth **G40**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- IPEMT is a Web-based application that provides access to engineering data.
- The toolset captures, manages, and provides broad accessibility to data generated during the project's engineering life cycle.
- IPEMT enables engineers and managers to view, search, and update project data (such as documentation, action items, review item discrepancies, and approved parts list) through a Web browser.
- IPEMT tools eliminate or reduce the labor-intense distribution of data products and provide a flexible flow of project engineering data through the life cycle.
- The design and implementation promotes already established interfaces and security.

COMMERCIAL USES/PUBLIC BENEFITS

- IPEMT would support repeatable processes for companies that design and manufacture products involving hardware and software.
- Project teams would increase their productivity.
- IPEMT supports most types of safety, quality, and productivity audits through a browser interface.
- It also provides company executives browser access to released project data.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Multibody Docking Dynamics

Booth **G29**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The ring finger docking dynamics (RFDD) simulation is a FORTRAN program used to simulate the dynamics of spacecraft docking.
- It was developed at JSC to determine the docking loads and capture performance for various docking mechanisms and docking mechanism concepts.
- Its modular structure easily allows modifications to simulate alternate contact interfaces and attenuation devices.
- It is currently being used to model spacecraft dockings and robotic arm-based berthing tasks required to assemble the International Space Station.
- RFDD provides a fast, reliable, portable, and modular tool for building computer-based math models necessary for studying spacecraft docking and berthing.
- It runs on computer platforms ranging from a Cray supercomputer to a PC running the Linux operating system.

COMMERCIAL USES/PUBLIC BENEFITS

- This program has modularity features that could be adapted to other simulations.

DEVELOPMENT STATUS: IN DEVELOPMENT

Nondestructive Evaluation Across NASA

Booth **G35**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- NDE is a methodology that allows for testing of hardware with little or no effects on performance.
- NASA routinely uses various NDE methods in many areas, including technique development, failure analysis, quality assurance, probability of detection studies, and development of new hardware.
- Besides using NDE at the various centers, NASA continues to perform NDE research and seek new developments in that area.

COMMERCIAL USES/PUBLIC BENEFITS

- NASA's technological advancements in this area will allow for commercial use in industry with mass manufacturing of expensive hardware.
- These methods will benefit failure analysis and upgrade procedures for new and emerging technologies.

DEVELOPMENT STATUS: IN DEVELOPMENT

Orbital Debris and Meteoroid Assessment and Protection

Booth **966**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- NASA environmental simulations and testing help determine the risk orbital debris poses, and safety standards promote environmentally friendly satellite deployments and operations.
- Spacecraft design techniques will mitigate the risk of damage from smaller debris and special shielding designs will protect most surfaces from damage caused by debris 1 cm in diameter and smaller.

COMMERCIAL USES/PUBLIC BENEFITS

- In addition to protecting commercial spacecraft and launch vehicles, shielding designs have potential for protective garments for law enforcement personnel and for armoring motor vehicles.
- Unique testing and analysis facilities are available for evaluating high-velocity impact damage.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Power and Thermal Model Analysis

Booth **G34**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- NASA is researching an advanced propulsion technology known as the Variable Specific Impulse Magnetoplasma Rocket (VASIMR).
- The Safety, Reliability, and Quality Assurance group is working on the mission assurance for this project.
- The objective is to develop thermal models using the thermal synthesizer system to simulate on-orbit and laboratory condition temperature responses of the VASIMR.
- We are also developing geometric and thermal models of the active thermal control system for the cooling of super-cooled magnets used in the VASIMR.
- Test temperatures will be correlated by adjusting plasma power dissipation.
- In addition, the project seeks to determine plasma power dissipation characteristics from experimental data and analysis.

COMMERCIAL USES/PUBLIC BENEFITS

- These models could be adapted for use for other systems where thermal control is a concern.

DEVELOPMENT STATUS: IN DEVELOPMENT

Quality Assurance and Analysis for Single-Walled Nanotubes

Booth **G31**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- Single-walled carbon nanotube material is a new, unique material with unusual electrical and optical properties.
- The material exhibits strong sensitivity to gas adsorption on the surfaces of the carbon nanotubes.
- This sensitivity to gas adsorption is affected by gas type and temperature.
- Conductivity measurements are made as a function of time relative to the introduction of a small pulse of various gases.
- These effects are being investigated jointly by the Safety, Reliability, & Quality Assurance group and Rice University.

COMMERCIAL USES/PUBLIC BENEFITS

- The data gathered from this research will provide a necessary information base for future sensor development.
- Such sensors can benefit the public by providing low-cost, sensitive detection of many hazardous gases.

DEVELOPMENT STATUS: IN DEVELOPMENT

Service Vehicles Analysis Tools for the International Space Station

Booth **G46**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- Several service vehicles will be flying to the ISS to support logistics such as supplying equipment and consumables, removing waste, and boosting altitude.
- The rendezvous, proximity operations and capture (RPOC) tool has been developed to precisely simulate the motions of these service vehicles.
- The simulation integrates oribital, robotic, contact and flex dynamics with models of spacecraft sensors, effectors, and guidance/navigation/control systems.
- RPOC currently simulates U.S., European, Japanese, and Russian service vehicles that will fly to the Space Station.
- This tool enables a range of analyses: "quick-look," highly detailed verifications, non-real-time batch runs, and real-time human-and-hardware-in-the-loop analyses.
- RPOC uses the Trick simulation environment used throughout JSC, which enables model-sharing and coordination with other NASA groups.

COMMERCIAL USES/PUBLIC BENEFITS

- Simulation of complex systems (non-real-time, real-time, hardware-in-the-loop, human-in-the-loop), both time and/or event driven
- Quick look at spacecraft or robotic capabilities
- Training on dynamic systems
- Verification support for spacecraft or robotics
- Detailed global positioning satellite analysis, including precision navigation

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Shuttle Cockpit Avionics Upgrade

Booth **929**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The CAU is a major Shuttle safety upgrade that will enhance crew awareness during critical flight situations.
- The CAU capitalizes on the new "glass cockpit" by providing additional display capability.
- The display improvements will provide integrated data source and graphics, thus adding crew insight for possible failures.
- The system will also provide enhanced caution and warning to find the root causes of problems.
- The upgrade will provide a symmetric cockpit and will display information on any display unit from any keyboard.

COMMERCIAL USES/PUBLIC BENEFITS

- This avionics development could be applied to a variety of applications in industry that may require human monitoring and intervention during a critical process.

DEVELOPMENT STATUS: IN DEVELOPMENT

Space Shuttle Multiple-Phase Integrated Probabilistic Risk Assessment

Booth **G32**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The probabilistic risk assessment model integrates the Orbiter and Shuttle propulsion elements to quantify existing hazards.
- Risks are assessed for all components (solid rocket boosters, main engines, and external tanks) and at all points of the timeline.
- Probabilistic risk assessment focuses on operator-training scenarios, factoring in the likelihood of occurence.
- The assessment also prioritizes system improvements and maintenance considerations.

COMMERCIAL USES/PUBLIC BENEFITS

- In any industry that creates or operates a system or interacting elements, probabilistic risk assessment identifies areas where risk should be reduced.
- Risk reduction applications can be used in the medical, education, manufacturing, and operation industries.

DEVELOPMENT STATUS: IN DEVELOPMENT

Space Shuttle Program Upgrades

Booth **929**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The Space Shuttle Program Upgrades Program is responsible for developing upgrades to keep the Space Shuttle a viable system for as long as it is required.
- The upgrade activities are focused on incorporating safety features and replacing obsolescent hardware and software.
- On display are upgrades that have already been incorporated into the Program, as well as those under consideration.

COMMERCIAL USES/PUBLIC BENEFITS

- New processes and methods used to upgrade existing hardware and software can provide the basis for new commercial technologies.

DEVELOPMENT STATUS: IN DEVELOPMENT

Stereo Imaging Velocimetry

Booth **G04**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- Stereo imaging velocimetry is a system used to track the motion of particles in a transparent liquid in three dimensions.
- The system consists of two cameras, oriented at 90 degrees from each other, observing a fluid experiment seeded with small tracer particles.
- Each camera records two-dimensional data of the seed particle motion in the observation volume.
- Three-dimensional data are obtained by computationally combining the two-dimensional information.

COMMERCIAL USES/PUBLIC BENEFITS

- Combustion intake, compression, expansion, exhaust studies
- Air flow studies around buildings
- Improved aerodynamics of automobiles and aircraft
- Avoiding "no-flow" regions in artificial hearts
- Analysis of crash dummy motion
- Modeling of continuous casting operations (steel, nonferrous alloys)
- Quieter airflow within auto heating and cooling ducts

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

System Reliability, Maintainability, Logistics, and Operations Simulation Tool

Booth **G36**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The Object-Oriented Simulation of Maintenance and Operations for Space Systems (OSMOSSYS) tool is a stochastic event-oriented simulation process.
- It integrates the complete configuration of a system to assess its rate of success.
- This integration accounts for the timeline profile, reliability, and maintainability of each component, as well as logistics support.
- The process can simulate the maintenance and resource demands and function availability of the systems modeled.
- In addition, OSMOSSYS can accurately predict spares demand.

COMMERCIAL USES/PUBLIC BENEFITS

- This tool is easily installed and used on a personal computer.
- It can benefit the design and maintenance planning of production/manufacturing/refinery plants.
- It has enough flexibility in the setup of the models to suit the level of detail desired (simple or complex).
- This is an excellent tool for determining whether an investment in technology will pay off in increased system reliability.
- OSMOSSYS development is already complete and is operational for multiple NASA projects.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Thermal Synthesizer System

Booth **G02**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The thermal synthesizer system originally was developed to further thermal design and analysis of spacecraft.
- It also is an excellent thermal analysis tool for conduction- and radiation-dominated heat transfer problems.
- The friendly user interface provides an integrated analysis environment by expediting model development, analysis, and results review.

COMMERCIAL USES/PUBLIC BENEFITS

- A "next-generation" thermal analysis tool for any engineering endeavor
- Automotive, chemical processing, and computer industries

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Using Micro Technology to Improve Hazardous Gas Detection Systems

Booth **G31**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- HGDSs are used to monitor the gases in the aft compartment of the Space Shuttle, and other locations, before and during launch.
- Accurate, timely readings are critical to the success of each launch.
- JSC is proposing to use the JPL miniature mass spectrometer due to its high sensitivity, lower power consumption (1-2 Watts), smaller size (5-10 cm), and faster response time (10-100ms).
- Because of its small size and weight, the device may be applied directly to the aft compartment with minimal volume and gas transport time.

COMMERCIAL USES/PUBLIC BENEFITS

- This method of real-time monitoring of gases could also be used for automation into other Caution and Warning systems.
- It can be used for gas or chemical analyses for exploratory purposes where human interaction is limited, such as wells, volcanoes, chemical plants, or factories, as well as space exploration.

DEVELOPMENT STATUS: IN DEVELOPMENT

X-38 Forward Trunnion Mechanism

Booth **2205**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- The X-38 crew return vehicle is structurally supported inside the Shuttle payload bay by trunnion pins.
- Five trunnion pins attach the X-38 spacecraft to its airborne support equipment.
- After the X-38 is removed from the payload bay, the forward trunnion pins must be retracted to provide a smooth aerodynamic surface.
- The X-38 forward trunnion pin mechanism uses compressed nitrogen for retraction.

COMMERCIAL USES/PUBLIC BENEFITS

- Applications that require the retraction of a structural pin

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

X-38 Spaceflight Test Vehicle V-201

Booth **2202**

TECHNOLOGY CATEGORY: PRODUCT DESIGN AND ANALYSIS

DESCRIPTION

- This vehicle will perform a spaceflight test of the crew return vehicle (CRV) in 2002.
- The Space Shuttle will carry it to orbit, where it will fly the entire CRV mission from deorbit burn through landing.
- This vehicle is being designed, manufactured, and assembled on site at JSC.
- It lands using a 7500-sq-ft steerable parafoil to reduce landing speed and to allow for autonomous flight and landing in the event of incapacitated crew members.
- Its basic structure has an aluminum frame and pressurized crew compartment, carbon fiber composite skin panels, and tiles and blankets for thermal protection.
- The vehicle has been designed with computer-aided design, manufactured with computer-aided manufacturing, and inspected with a computer-based laser tracking system.

COMMERCIAL USES/PUBLIC BENEFITS

- A small, in-house team using cutting-edge technology to achieve something that has never been done before

DEVELOPMENT STATUS: IN DEVELOPMENT

Atmospheric Reentry Materials and Structures Evaluation Facility

Booth **G06**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The Atmospheric Reentry Materials and Structures Evaluation Facility is a high-efficiency, 10-million-watt, direct-current, arc-jet complex.
- It is one of the three remaining high-power arc-jet facilities in the United States.
- Its primary function is to simulate the thermal environment associated with Earth entry in order to screen, develop, and certify spacecraft heat shields.
- The high-energy thermal environment surrounding a spacecraft during entry is produced by electrically heating gas mixtures simulating air.
- The superheated flow is then expanded through supersonic/hypersonic nozzles into a reduced pressure chamber.

COMMERCIAL USES/PUBLIC BENEFITS

- Unique, high-temperature materials testing

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Commercialization of Facilities

Booth **G14**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- JSC has numerous laboratories and test facilities that are not necessarily used around the clock.
- Many of these facilities (most of which are on display at I2000) are available for use by the private sector on a non-interference basis.
- The Thermal Vacuum Test Complex, Vibration & Acoustic Test Facility, Anechoic Chamber, and Electromagnetic Interference Test Facility are included on guided tours.
- The Structures Test Laboratory, Video Digital Analysis System Laboratory, and Six-Degrees-of-Freedom Sensor Test Facility are also available for outside use.
- The Earth Observation Laboratory and Computing Systems Laboratory are included, as well.

COMMERCIAL USES/PUBLIC BENEFITS

- Advanced test and research capabilities are made available to companies that might not otherwise have a chance to access them.
- This arrangement ensures the maximum use of government-owned facilities and the most payback for the taxpayer.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Cryogenics Test Bed

Booth **G23**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The Cryogenics Test Bed is a collaboration of industry, aerospace, and research partners focused on technology development.
- Its mission is to bring together the mutual elements of research, industry, and training in the field of cryogenics to advance technology development for spaceports of the future.
- The Cryogenics Test Bed has four technology focus areas: thermal insulation systems, cryogenic components, propellant process systems, and low-temperature applications.
- Expertise includes experiment design and investigation, system design and prototypes, and engineering test and evaluation.
- Industry areas include cryogenic and vacuum testing, specialized system design/engineering service, component test and evaluation, and prototype construction.
- The energy-efficient storage, transfer, and use of cryogens and cryogenic propellants on Earth and in space is the common element of the work of the Test Bed.

COMMERCIAL USES/PUBLIC BENEFITS

- Kennedy Space Center's unique facilities and capabilities provide an ideal test bed environment for product development and testing.
- Cooperation with national and international societies and institutions for the advancement of refrigeration and low-temperature technologies is a key part of this vision.
- The goal of the Test Bed is to promote public awareness of the benefits and uses of cryogenic technologies through the theme of energy and energy conservation.

DEVELOPMENT STATUS: IN DEVELOPMENT

Determination of Aeroheating Environments for Space Vehicles

Booth **518**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- Advanced aerothermodynamic testing and analysis tools are being developed at Langley Research Center.
- Once such tool is a revolutionary new aerodynamic heating test technique called phosphor thermography.
- This new technique provides three orders of magnitude more wind tunnel data of aeroheating environments, in an order of magnitude less time and cost than conventional techniques.

COMMERCIAL USES/PUBLIC BENEFITS

- This technology can be used in the early phases of the design process to develop safer, more reliable space transportation systems.

DEVELOPMENT STATUS: IN DEVELOPMENT

Early Use of the International Space Station

Booth **925**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The ISS will provide a long-term orbital laboratory where international research in biology, chemistry, physics, and medicine can be conducted.
- A great deal of this research and technology utilization is already planned for the ISS, even in the very near term.
- The ISS Payloads Office helps coordinate the planning and implementation of that research.

COMMERCIAL USES/PUBLIC BENEFITS

- Research on the ISS is expected to yield significant benefits for life on Earth, as well as in space.
- There should be improvements in materials, electronic devices, optical fibers, telecommunications, and combustion.
- Medical research and biotechnology will help develop improved methods for replacing damaged organs and tissues.
- The ISS will enable a deeper insight into the Earth system and its environmental response to natural and human-induced variations in air quality, climate, land use, food production, ocean and fresh wa
- Crystals grown in space may contribute to new or improved treatment for numerous diseases, as well as improved catalysts to extract oil, thus enhancing the American petroleum industry.
- The ISS will serve as a platform for broadening our knowledge about the universe and our place in it.
- It will also serve to inspire and motivate our youth to pursue education and careers in science and technology.

DEVELOPMENT STATUS: IN DEVELOPMENT

Energy Systems Test Area

Booth **938**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The ESTA comprises five facilities that provide space environment simulations for testing space vehicle subsystems, components, and payloads.
- Test environments include deep space vacuum, elevated pressures, hot and cold temperatures, and launch vibration.
- Test capabilities include batteries, pyrotechnics, hydrogen and oxygen, fuel cells, planetary resource utilization, electromechanical actuators, and cryogenics.
- Support services at ESTA include chemical analysis, machine shops, and a Class 10,000 clean room.
- A guided tour of one of the ESTA facilities is available.

COMMERCIAL USES/PUBLIC BENEFITS

- Medical applications, including heart assist devices and batteries (e.g., pacemakers and hearing aids)
- Automotive applications, including fuel cells and propellant blenders for efficiently and safely producing propellant for automobile air bags
- Chemical process applications, including cryogenic fluid storage and distribution, as well as small chemical reactors for by-product fluid conversion to useful products
- Environmental applications, including verifying survivability of hardware and systems under harsh conditions

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Human Research Facility

Booth **G26**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The Human Research Facility is dedicated to life sciences research and is presently scheduled to be launched in February 2001 and placed on board the International Space Station.
- Housed within a rack in the US. Lab module, it will provide research facilities during the Space Station assembly phase.
- A primary point of interest of the exhibit is an interactive ultrasound quiz that is based on images generated by the ultrasound system mounted in the rack.
- Additional information is available concerning the rack layout, rack power and data connections, instrument development, and scientific investigations the facility supports.
- Also described are the effects of weightlessness on the human body and the general applicability of the facility in terms of long-duration spaceflight.

COMMERCIAL USES/PUBLIC BENEFITS

- An educational benefit is derived by using spaceflight physiological data in education to help understand the functions of the human body in normal gravitational circumstances.
- Data that clearly show alterations in the body in the microgravity environment of the International Space Station can be used to illustrate the adaptability of the body to changing environments.
- Additionally, redesigning medical instrumentation for facility use has led to advances in miniaturization and repackaging of medical instrumentation.
- These advances may lead to increased portability of medical instruments and lead to new concepts in the commercial design of medical instrumentation.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

International Space Station as a Test Bed for Commercial Spacecraft Technologies

Booth **927**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- External sites on the International Space Station can function as a test bed on which to validate new technologies for commercial communications and remote sensing satellites.
- Pallet-based testing at external sites on the Station can replace flying expensive and time-consuming technology demonstration spacecraft.
- Space Station palletized payloads can validate in-space operation of multispectral imagers, phased array radio frequency communications packages, and optical communications systems.
- Pallet-based testing at external Station sites can also be used for advanced satellite power and thermal management systems, precision deployable structures, and materials.

COMMERCIAL USES/PUBLIC BENEFITS

- Reduced technology development cycle

DEVELOPMENT STATUS: IN DEVELOPMENT

Light Microscopy Module With Sample Cells

Booth **G04**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The light microscopy module consists of an upright microscope for optical microscopy of fluids samples.
- It features thin-film interferometry, laser tweezers, confocal microscopy, and spectrophotometry.
- The module will be launched to the International Space Station in mid-2004, and subsequently will be integrated into the Glenn Research Center Fluids and Combustion Facility.

COMMERCIAL USES/PUBLIC BENEFITS

- The light microscopy module mini-facility will benefit the public by providing high-power optical microscopy in microgravity for periods of several years.
- This should enable controlled experiments of many varieties (complex fluids, two-phase flow, biology, etc.) to occur.
- The knowledge derived from these experiments could lead to advances in strong ceramics, viable three-dimensional lithograpy techniques, and high-performance optoelectronic devices.
- Industry could benefit from the design and manufacturing technology associated with the sample cell hardware items.

DEVELOPMENT STATUS: IN DEVELOPMENT

Micron Accuracy Deployment Experiment

Booth **927**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The MADE is a reusable facility for on-orbit validation of precision deployable structures.
- MADE will measure the microdynamics motion surrounding a precision test article.
- MADE will measure a variety of different deployment structures and configurations by using a microdynamics vibration interferometer and a nanometer accuracy metrology system.
- Microdynamics vibration interferometer involves a laser that measures the position of up to six targets on a test article.
- Nanometer accuracy metrology system uses a charged-coupled device camera attached to a long-distance microscope to capture target images and compare them with prerecorded positions.

COMMERCIAL USES/PUBLIC BENEFITS

- Creating more stable deployable structures

DEVELOPMENT STATUS: IN DEVELOPMENT

Neutral Buoyancy Laboratory

Booth **934**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The Neutral Buoyancy Laboratory houses a 40-ft-deep, 102-ft by 202-ft tank with 6.2 million gallons of water that is heated to 86 degrees F.
- In this pool, astronauts and engineers participate in flight hardware design evaluations, ensuring the optimum devlopment of the hardware for safety and spacewalking efficiency.

COMMERCIAL USES/PUBLIC BENEFITS

- Engineering test and evaluation of underwater sensors, SONAR, diving equipment, or any other underwater hardware
- Training for search and rescue and underwater diving and salvage

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Oxygen Hazards Analysis and Testing

Booth **968**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- White Sands Test Facility is particularly involved in the testing and analysis of fire and explosion hazards in oxygen systems.
- White Sands performs compatibility, ignition, and flammability testing of oxygen systems and materials.
- Its personnel have extensive expertise in performing hazard and failure analysis of oxygen system materials, components, and integrated assemblies.

COMMERCIAL USES/PUBLIC BENEFITS

- High-pressure oxygen is used in a rapidly expanding variety of commercial applications.
- Examples include medical and aircraft life support systems, sports/recreation, chemical processing, and manufacturing.
- Hidden dangers may exist in many commonly encountered oxygen systems, and failure consequences may be severe.
- White Sands has developed unique facilities, equipment, and expertise for identifying and correcting these dangers.
- These assets and capabilities are available for use by commercial customers on a reimbursable basis.
- Training is available in handling and maintaining oxygen systems, and in minimizing risks when working with these systems.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Radio Frequency Test Facilities

Booth **939**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The RF test facilities include three separate facilities used to conduct RF electromagnetic test activities.
- The anechoic chamber absorbs 99.9% of the incident microwave radiation.
- The anechoic chamber measures 150 ft by 50 ft by 50 ft and can accommodate large antennas and space structure mockups.
- The antenna range serves a similar function but uses the free space outdoors to measure antenna performance.
- The electromagnetic interference test facility measures RF emissions from equipment and its susceptibility to emissions in order to qualify the equipment for space.

COMMERCIAL USES/PUBLIC BENEFITS

- Iteratively designing, tuning, and verifying the RF performance of equipment using full-scale models
- Testing equipment under a wide range of electromagnetic radiation conditions to determine its performance in harsh environments

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Reduced-Gravity Research Program

Booth **9906**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The KC-135 aircraft (similar to a Boeing 707) is a microgravity test facility for basic research and development of new equipment, techniques, and processes.
- The aircraft flies a "roller coaster" maneuver to produce periods of approximately 25 seconds of weightlessness.
- The cargo area is approximately 60 ft long, 10 ft wide, and 7 ft high.
- Electrical power is provided along with an overboard vent system, photographic lighting, and an S-band uplink/downlink for real-time data and voice transmission.
- There are 23 seats on board to accommodate researchers.
- Ground facilities supporting this program include a test equipment buildup area, briefing room, computer stations, and telephones.
- Typical flights last approximately 2 hours, and consist of 40 parabolic maneuvers.

COMMERCIAL USES/PUBLIC BENEFITS

- The Reduced Gravity Program offers this unique opportunity for microgravity experiment and payload development to government, university, and other researchers.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Space Radiation Health—NASA's Unique Reseach Facilities

Booth **G28**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The space radiation environment poses several health risks to crewmembers, particularly for long-duration flights such as the International Space Station, and is a critical concern for trips to Mars.
- JSC's Radiation Health Office (RHO) has been overseeing the development and construction of unique accelerator research facilities for ground-based simulation of space radiation environments.
- NASA's Radiobiology Research Center at the Loma Linda University Medical Center has been uSing the high-energy proton beam for research and assessment of spacesuit and spacecraft materials.
- The RHO has been developing visualization models to depict the radiation environment in the Space Station modules and for assessing the health risk of future exploration missions such as Mars.
- Radiobiology investigations from the RHO also include space environment simulated irradiation on human blood cells and analysis of resultant chromosome aberrations.

COMMERCIAL USES/PUBLIC BENEFITS

- This radiation environment research highlights the need for technological advancement in radiation shielding materials, wherever human exposure is a concern.
- NASA's radiobiology research could lead to the development of biomarkers to assess the progression of cancer cells and possible development of pharmacological compounds for cancer treatment.

DEVELOPMENT STATUS: IN DEVELOPMENT

Space Shuttle Flight Computer Emulator

Booth **3004**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- This software package emulates the Space Shuttle flight computers and many other avionics components.
- It can run the binary image of the Space Shuttle flight software.
- The software package interacts with high-fidelity vehicle subsystem and environment models for a complete simulation.
- It generates Mission Control Center data streams for user interaction.
- The software package runs on conventional computers with Unix operating systems.

COMMERCIAL USES/PUBLIC BENEFITS

- Can be used as a development and test kit for Space Shuttle flight or ground software
- Can be used as a vehicle simulator for Space Shuttle training applications
- Can be used as part of an embedded system for Space Shuttle payload development and testing

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Thermal/Vacuum Chamber

Booth **940**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- This is the world's largest thermal/vacuum chamber.
- It is used to expose space hardware, space systems, and satellites to a simulated space environment.
- It has a 65-foot working diameter, a 90-foot working height, and a 40-foot diameter door that weighs 40 tons.
- This chamber has solar simulation capability.
- Chicago Bridge and Iron built the chamber in 1963 to test the Apollo Command and Service Module.

COMMERCIAL USES/PUBLIC BENEFITS

- The chamber simulates a space environment to ensure product performance.
- The chamber is used to verify thermal radiation analyses.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Vibration and Acoustic Test Facility

Booth **937**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The Vibration and Acoustic Test Facility has the capability to conduct vibration and acoustic tests, modal tests and analysis, and noise emission tests.
- The sonic fatigue laboratory chamber, which is 40 ft by 19.3 ft by 16.1 ft high, can expose structural components to sound pressure levels up to 166 decibels.
- The larger spacecraft acoustic laboratory, which is 38.9 ft by 47.3 ft by 75 ft high, can be used for acoustic tests up to 162 decibels.
- The general vibration laboratory has fixed test beds with up to 40,000 force-pound capability.
- An analog data system capable of recording up to 390 channels of response data is available to serve all laboratories.

COMMERCIAL USES/PUBLIC BENEFITS

- The unique capabilities of the Vibration and Acoustic Test Facility are available to provide testing services.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

WB-57 High-Altitude Research Aircraft

Booth **9904**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- The WB-57 aircraft, used for high-altitude research, flies at altitudes in excess of 65,000 feet for greater than 6 hours.
- The aircraft serves as a platform for various types of scientific equipment, flown in the payload bay, nose, and wing pods.
- The payload bay is outfitted with a pallet system for easy installation and removal, allowing experimenters easy access to equipment.

COMMERCIAL USES/PUBLIC BENEFITS

- Map the thermal features of a subsurface lava flow
- Investigate sulfur dioxide pollution near power plants
- Examine ozone degradation in the exhaust plumes of rockets

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

White Sands Test Facility

Booth **967**

TECHNOLOGY CATEGORY: RESEARCH AND TEST FACILITIES

DESCRIPTION

- JSC's White Sands Test Facility in New Mexico has many unique hazardous test capabilities.
- There are eight static test stands for testing rocket propulsion systems (five cells for firing at simulated space vacuum conditions).
- White Sands has facilities for cleaning and rebuilding Space Shuttle and Space Station hardware, such as rocket engines and life support system components.
- Large-scale and laboratory facilities are used for testing potentially hazardous materials which may be toxic, corrosive, flammable, explosive, or highly reactive.
- Hypervelocity "guns" are employed to simulate meteorite and orbital debris impact, using projectiles up to 1 inch in diameter and velocities over 7 km/sec.
- Two laser-leveled 7-mile-long dry lakebed runways at White Sands are used for astronaut training and serve as an alternate Shuttle Orbiter landing site.

COMMERCIAL USES/PUBLIC BENEFITS

- Many commercial products and processes must operate safely in toxic, corrosive, or otherwise hazardous environments.
- Ignition, flammability, corrosion, and material degradation are important safety and economic concerns.
- Unique White Sands facilities, equipment, and expertise enable testing and analysis of raw materials, components, and complete integrated systems.
- These services are available to commercial customers on a reimbursable basis.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

Goddard Space Flight Center's Earth and Space Science Technology Showcase

Booth **957**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- NASA Goddard Space Flight Center's challenging and technologically demanding Earth science and space science missions generate a wealth of advanced technology.
- Numerous technology commercialization successes and opportunities exist in both the Earth and space science areas.

COMMERCIAL USES/PUBLIC BENEFITS

- Through technology transfer and commercialization, Goddard is improving the standard of living for the U.S. population, strengthening the economy, and stimulating the demand for U.S. goods and service

DEVELOPMENT STATUS: ENGINEERING PROTOTYPE COMPLETE

Marshall Space Flight Center Commercial Technology Office

Booth **956**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- The Marshall Space Flight Center Commercial Technology Office provides information about beginning formal partnering relationships between NASA and external customers.
- Review success stories describing various commercialization projects and activities.
- View information on commercial technologies such as VPS forming of Cu-8Cr-4Nb, ceramic composite blisk manufacturing process, ternary gas plasma welding torch, quick connect fastener, and more.

COMMERCIAL USES/PUBLIC BENEFITS

- This office helps the private sector obtain NASA technology.

DEVELOPMENT STATUS: IN DEVELOPMENT

Marshall Space Flight Center Minority- and Women-Owned Business Initiative

Booth **956**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- NASA has an initiative to provide technology transfer assistance to minority- and women-owned technology companies.
- Marshall Space Flight Center is very involved in this initiative and can help such businesses with their technological needs.

COMMERCIAL USES/PUBLIC BENEFITS

- High-tech partnerships between NASA and minority- and women-owned businesses help to diversify and improve the economy.

DEVELOPMENT STATUS: IN DEVELOPMENT

Mid-Continent Technology Transfer Center

Booth **953**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- MCTTC is one of six NASA-funded regional technology transfer centers.
- MCTTC converts the wealth of technology available from NASA centers and federal laboratories into opportunities for American businesses.
- An extensive affiliate network covering the 14-state mid-continent region helps to bring businesses and NASA technologies together.
- MCTTC is a partner in NASA's initiative to transfer technology to American businesses.
- MCTTC provides business, technical and research support to U.S. companies in our region that are interested in licensing or partnership opportunities with JSC technologies.

COMMERCIAL USES/PUBLIC BENEFITS

- MCTTC's knowledge of both the business interests in the mid-continent region and the available NASA technologies allows them to play matchmaker and find NASA technologies that fit industry needs.
- MCTTC provides general business support to companies interested in receiving NASA or federal technologies, such as assistance developing business plans and access to venture capital resources.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL

NASA-Dreamtime Multimedia Agreement

Booth **977**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- NASA has undertaken a partnership with Dreamtime, Inc., to collaborate in promoting NASA's mission and educating the public about the space program.
- A Web-searchable multimedia database will be developed and filled with NASA archived imagery.
- Dreamtime will share the use of state-of-the-art high-definition television equipment on board the International Space Station and Space Shuttles and at NASA centers.
- Documentaries and miniseries will also be produced.

COMMERCIAL USES/PUBLIC BENEFITS

- NASA's message will get out to a much broader audience, including educational venues as well as the general public.
- This precedent-setting agreement may encourage other commercial ventures in the future.

DEVELOPMENT STATUS: IN DEVELOPMENT

Small Business Innovation Research

Booth **945**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- Congress established the SBIR program to provide increased opportunities for small businesses.
- Small businesses receive up to $670,000 of SBIR program funds for innovative concepts that meet NASA's technical requirements.
- While NASA has royalty-free rights for the use of the products and data developed within this program, the small business owns any resulting data, copyright, or patents.

COMMERCIAL USES/PUBLIC BENEFITS

- Smaller businesses that might otherwise have difficulty acquiring research funds are able to participate in technology development.
- The technical business economy is further diversified through these increased opportunities.

DEVELOPMENT STATUS: IN DEVELOPMENT

Stennis Space Center Commercial Technology Program Booth 955

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- Stennis Space Center has developed expertise in many areas that serve as sources for technologies and applications.
- Technology areas include, but are not limited to, testing and monitoring, nonintrusive instrumentation, sensors, telecommunications, cryogenics, standards and calibrations, and plume diagnostics.
- The Commercial Technology Program at Stennis Space Center assists in the transfer and commercialization of these technologies.

COMMERCIAL USES/PUBLIC BENEFITS

- Technology opportunities are offered to the private sector through licensing opportunities, dual-use development projects, contracts/agreements, and technology assistance.

DEVELOPMENT STATUS: IN DEVELOPMENT

Technology Outreach Program

Booth **954**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- The Technology Outreach Program is a cooperative program designed to speed the transfer of space technology into the private sector.
- It allows small businesses to receive up to 40 hours of free technical assistance from experts in the space and educational communities.
- The Technology Outreach Program is sponsored by JSC, the Clear Lake Area Economic Development Foundation, 17 aerospace contractors, 2 community colleges, a university, and the City of Houston.

COMMERCIAL USES/PUBLIC BENEFITS

- The Technology Outreach Program allows small businesses to partner with NASA and space industry contractors and receive up to 40 hours of free technical assistance.
- The program assists a variety of small businesses from various industries with design verification, materials analysis, or testing.

DEVELOPMENT STATUS: IN DEVELOPMENT

Technology Transfer & Commercialization

Booth **945**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- JSC is the world leader in the technologies that enable human spaceflight, including life support, environmental control, robotics, propulsion, structures, mechanisms, materials, and ops control.
- NASA's goal is to enable the use of NASA-developed technologies in the private sector.
- U.S. companies can license NASA technologies to add to their portfolios.
- NASA and private industry and academia can form cooperative arrangements to develop, test, or use technologies.
- NASA provides significant funding opportunities for small businesses to perform technology research and development projects.
- NASA provides technical assistance to businesses with technology challenges.

COMMERCIAL USES/PUBLIC BENEFITS

- NASA developed technologies influence every facet of our everyday lives, from sunglasses to medical equipment.
- One of NASA's focuses is on miniaturization of equipment that could be applicable to your industry.
- Whatever your industry, JSC has technology that can make a difference.

DEVELOPMENT STATUS: IN DEVELOPMENT

University of Houston—NASA Technology Commercialization Incubator

Booth **947**

TECHNOLOGY CATEGORY: TECHNOLOGY COMMERCIALIZATION

DESCRIPTION

- The UH-NASA Technology Commercialization Incubator combines research and development capabilities with business training and support for businesses interested in receiving NASA technologies.
- The UH-NASA Incubator is one of nine NASA-funded incubators across the country.
- It furthers the development of NASA technologies to promote successful commercialization.
- The Incubator provides entrepreneurship training and business support to help the formation of start-up companies and help them succeed.

COMMERCIAL USES/PUBLIC BENEFITS

- The UH-NASA Incubator is a partner in JSC's initiative to increase exposure to and awareness of NASA technologies.
- The Incubator fosters business development based on scientific research.
- It encourages the development of start-up companies based on NASA technologies.
- The Incubator promotes local entrepreneurship and economic development in the Houston area.

DEVELOPMENT STATUS: DEVELOPMENT COMPLETE/OPERATIONAL